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Technical Report

December 1989

Belt Use in Serious Impacts Estimated From Fatality Data

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16. Abstract

Drivers in fatal crashes were less frequently reported (by the police) to have been using their safety belts if the driver was reported to have been exceeding the speed limit, to have been drinking, or to have had previous crashes. Reported belt use was also lower among male drivers, in older cars, and at night.

To test the effects of these differences between belt users and nonusers, belt effectiveness was estimated with statistical adjustments for crash speed, driver age, and alcohol use. Controlling for crash speed produced belt effectiveness estimates that were lower than those produced from the unadjusted data, but the results are within the range of previous agency estimates. Controlling for driver age and alcohol use produced belt effectiveness estimates that were essentially the same as those produced from the unadjusted data. Thus, although belt users and nonusers differed in ways that are important for designing programs to increase belt use, these differences did not greatly bias estimates of belt effectiveness in crashes.

This analysis confirms the agency's estimate that wearing a belt reduces an occupant's risk of fatality and serious injury by 40 to 55 percent. State belt use laws, education programs, and enforcement activities that increase belt use in crashes will reduce fatality and injury rates. However, drivers who are most likely to be involved in a serious crash (those who drink before driving or drive too fast) are also those who are least likely to use belts.

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Summary

Drivers in fatal crashes were less frequently reported (by the police) to have been using their safety belts if the driver was reported to have been exceeding the speed limit, to have been drinking, or to have had previous crashes. Reported belt use was also lower among male drivers, in older cars, and at night.

To test the effects of these differences between belt users and nonusers, belt effectiveness was estimated with statistical adjustments for crash speed, driver age, and alcohol use. Controlling for crash speed produced belt effectiveness estimates that were lower than those produced from the unadjusted data, but the results are within the range of previous agency estimates. Controlling for driver age and alcohol use produced belt effectiveness estimates that were essentially the same as those produced from the unadjusted data. Thus, although belt users and nonusers differed in ways that are important for designing programs to increase belt use, these differences did not greatly bias estimates of belt effectiveness in crashes.

This analysis comfirms the agency's estimate that wearing a belt reduces an occupant's risk of fatality and serious injury by 40 to 55 percent. State belt use laws, education programs, and enforcement activities that increase belt use in crashes will reduce fatality and injury rates. However, drivers who are most likely to be involved in a serious crash (those who drink before driving or drive too fast) are also those who are least likely to use belts.

Objectives

The objectives of this paper were: first, to identify differences in belt use rates in fatal crashes by the situations, vehicles, and drivers involved; and second, to evaluate the effects of these differences on estimates of belt effectiveness in crashes. The identified differences between belt users and nonusers can also be used by the traffic safety community to design belt use education programs to reach those least likely to use belts and to direct education and enforcement activities to driving situations where belts are least frequently used.

Reliable comparisons of belt users and nonusers in crashes were made before there were any state belt use laws. However, thirty-four states and the District of Columbia now have belt use laws. These laws increase belt use in traffic, in all crashes, and in fatal crashes. The larger number of belted drivers in serious crashes provides an opportunity for detailed comparisons of current belt users and nonusers. But belt use laws also reduce the reliability of reported belt use in crashes by providing a reason for unbelted drivers to report that they were belted. For legal, insurance, and personal reasons, unbelted drivers are now more likely to report belt use than they were in the past. Because belt use is now unreliably reported in most towaway crashes, this paper uses current data from fatal crashes to explore differences between belt users and nonusers.

Differences in Belt Use

Belt use was lower on weekends (about 31 percent on Saturdays and Sundays) than on weekdays (about 38 percent on Monday through Friday). However, this difference appeared to be largely accounted for by the greater tendency of weekend crashes to occur at night. Belt use was highest just before noon (49 percent) and lowest just after midnight (22 percent). After controlling for hour of the day, there were smaller differences in belt use by day of week among those at risk of fatality.

Belt use increased with increasing speed limit (from 30 percent for roads with speed limits under 30 miles per hour (mph) to 38 percent for roads posted at 60 or 65 mph) and decreased with increases in excessive driver speed (from 47 percent for drivers traveling at least 10 mph under the speed limit to 19 percent for those traveling 20 mph or more over the limit). However, after controlling for excessive driver speed, there was little difference in belt use by speed limit. Fatal crashes on low speed roads tended to involve excessive speed (that is, higher travel speeds) because fatality would have been unlikely at the posted speed limit, and drivers who were speeding tended to be belted less frequently than were drivers who were not speeding.

Drivers of lighter cars in potentially-fatal situations were more frequently belted than were drivers of heavier cars (36 percent for minicompacts, compared to 23 percent for the largest cars). However, the difference appeared to be accounted for by differences in car age. In these data, heavier cars tended to be older than lighter cars, and safety belt use decreased with increasing car age (by about 3.7 percent for each year, after controlling for differences in driver age, for crashes that occurred in 1987 and 1988).

A review of 1975 through 1984 data (before the first state safety belt use laws were enacted) showed that as cars in any model year aged, driver belt use in crashes decreased. Thus, the lower belt use in older cars in 1987 and 1988 appeared to be primarily an effect of how older cars were used (aside from the effects accounted for by differences in driver age), rather than an effect of design improvements (that might, for example, make safety belts easier to use in more recent cars).

Older drivers at risk of fatality were more frequently belted than were younger drivers. Belt use increased an average 4 percentage points for each ten-year increase in driver age, after accounting for differences in car age. Within any driver age category, belt use by women drivers was 12 percentage points higher than it was for men.

Drivers who had been drinking were less frequently belted (19 percent) than were drivers who were known not to have been drinking (46 percent). Belt use did not differ greatly by the number of passengers, except that drivers with a single passenger appeared to have a slightly higher belt use rate. For drivers who had not been drinking, the frequency of belt use decreased with increases in the number of previous crashes. However, even among nondrinking drivers with two or three previous crashes, belt use was twice as high (38 percent) as for drivers who had been drinking (19 percent). For drivers who were reported to have been drinking, belt use was uniformly low, regardless of the number of previous crashes.

Belt Effectiveness Estimates

The observed differences between belt users and nonusers could bias belt effectiveness estimates. First, unbelted driver fatalities were occupants of vehicles that crashed at greater speeds, and speed increases the risk of fatality in a crash. Second, unbelted driver fatalities tended to be younger, and younger people have a lower fatality risk given an injury. Third, unbelted driver fatalities were more likely to have been drinking before the crash, and it has been suggested that alcohol may interfere with the body's ability to recover from an injury. The effect of each of these three confounding factors was tested in the crash data.

Adjusting for differences in crash severity using either the extent of damage or the estimated instantaneous change in vehicle velocity during impact (the delta V) lowered the estimate of the effectiveness of safety belts in preventing driver moderate or serious injury in towaway frontal crashes. The moderate injury rate for belted car drivers in the National Crash Severity Study (NCSS) was 56 percent, as compared to 43 percent when the estimate was adjusted for differences in the extent of vehicle frontal damage and 43 percent when the estimate was adjusted for differences in the estimated instantaneous change in vehicle velocity during impact (the total delta V). For serious injuries, the three effectiveness estimates were 51 percent, 34 percent, and 43 percent. However, belt effectiveness was still estimated to be substantial and within the range of previous agency estimates.

To account for differences in driver age, the effectiveness of safety belts in preventing fatality was estimated for cars in which both the driver and the right front passenger were between 20 and 39 years old. Comparing the belt use and fatality outcomes for the driver and the right front passenger (using the matched-pairs analysis technique), safety belts were estimated to be as effective in preventing fatality for young adults as for all ages combined. Applying this technique to the 1984 Fatal Accident Reporting System (FARS) data produced estimates that safety belts were 44 percent effective in preventing fatalities of all ages and 45 percent effective when the analysis was restricted to cars with both a young driver and a young right front passenger (both between 20 and 39 years old). Similar results were obtained from the 1987 data (59 percent and 61 percent effective, respectively). Thus, it appears that belt effectiveness estimates are not seriously confounded by age differences between belt users and nonusers.

To account for differences in alcohol use, the effectiveness of safety belts in preventing fatality was estimated for cars in which the driver and the right front passenger were either both reported to have been drinking or both reported to not have been drinking. Comparing belt use and fatality outcome with the matched-pairs technique, safety belts were estimated to be as effective in preventing fatality for those who had been drinking and for those who had not been drinking as they were for all situations combined. When applied to the 1984 FARS data, this technique produced estimates that safety belts were 44 percent effective in preventing fatality overall, compared to 42 percent when both the driver and the right front passenger were reported by the police to not have been drinking. There were inadequate data available for cars where both the driver and the right front passenger were reported by the police to have been drinking, and this situation could not be analyzed from the 1984 data.

A similar analysis of the 1987 data produced estimates that safety belts were 59 percent effective overall, 54 percent effective when both the driver and the right front passenger were reported to have been drinking and 56 percent effective when both were reported to not have been drinking. If the lower fatality rates of belted drivers were caused by their lesser alcohol use (and so their better healing, given an injury), it seems there should be little or no estimated effectiveness of safety belts conditional on alcohol use or nonuse. Thus, it appears that differences in alcohol use between belt users and nonusers are not the reason for the lower fatality rates of belted drivers.

Conclusion

There are important differences between belt users and nonusers in their crash situations, vehicles, and personal characteristics. These differences are important considerations in designing state education and enforcement programs. However, these differences do not account for the lower fatality and injury rates of belted drivers. It appears that the belts themselves prevent fatality and reduce injury severity and that further increases in belt use will reduce casualties in crashes.

Background

The traffic safety community recognizes that when only some people use safety belts, belt users may differ in important ways from nonusers. For example, driver belt use in towaway crashes in the National Crash Severity Study (NCSS) during 1977 and 1978 (before any state had a belt use law) was higher among women, among those between 25 and 49 years old (as compared to all younger and all older people), in the smallest cars, and in urban areas. Belt use tended to be higher in newer cars, but the comparisons were confounded by the ignition interlock systems installed in cars built in the mid-1970's (S. Partyka, Restraint Usage and Effectiveness on the National Crash Severity Study, NHTSA, DOT-HS-805-151, September 1979).

Estimating the benefits of safety belt use is complicated by differences in who uses belts and under what conditions, and the resulting differences in impact type and crash severity. Estimates of belt effectiveness in preventing death and injury are greater than actual benefits unless these differences are accounted for in the analysis. The Highway Safety Research Center used statistical controls for crash configuration, vehicle damage severity, vehicle weight, and occupant age to correct for differences between belted and unbelted occupants (D. Reinfurt, C. Silva, and A Seila, A Statistical Analysis of Seat Belt Effectiveness in 1973-1975 Model Cars Involved in Towaway Crashes NHTSA, DOT-HS-802-035, September 1976). Adjusting for differences in these four factors reduced the estimates of belt effectiveness, as compared to those derived from the unadjusted data.

Later, the National Highway Traffic Safety Administration (NHTSA) adjusted for damage area and severity in evaluating the frontal occupant protection standard. The adjustments to the 1977 through 1983 towaway crash data produced lower estimates of safety belt effectiveness than were calculated from the unadjusted data (S. Partyka, "Seat Belt Effectiveness Estimates Using Data Adjusted for Damage Type," January 1984; printed in Papers on Adult Seat Belts -- Effectiveness and Use, NHTSA, DOT-HS-807-285, June 1988). This method was used on a larger data set in producing the Final Regulatory Impact Analysis: Amendment to Federal Motor Vehicle Safety Standard 208, Passenger Car Front Seat Occupant Protection (NHTSA, DOT-HS-806-572, July 1984).

It is important to understand differences between the driving population and people involved in fatal crashes. However, since the passage of state safety belt use laws, it has become more difficult to identify belt use in crashes. For example, the Highway Safety Research Center analyzed North Carolina belt use data and concluded that after the state belt law went into effect (and again after fines were imposed), unbelted crash victims were more likely to report to the police that they had been using a belt than they had been before (W. Hunter, D. Reinfurt, and M. Hirsch, Analysis of Occupant Restraint Issues from State Accident Data: First Year Report, HSRC-MP 40, September 1988). There is no reason to believe that the North Carolina experience is unusual, because reported belt use has increased by unrealistic amounts in many states. Thus, while the need to adjust for crash severity and victim vulnerability remains, the task has been made much more difficult by biases in belt use reporting.

Hunter, Reinfurt, and Hirsch suggest, based on the North Carolina data, that belt use reporting in fatal crashes may be more reliable than reporting in other towaway crashes, or in crashes in general. Analysis of the Fatal Accident Reporting System (FARS) data also indicates that safety belt use may be better reported in fatal crashes. For example, belt effectiveness estimates were made from the 1982 through 1987 fatality data (S. Partyka, "Belt Effectiveness in Pickup Trucks and Passenger Cars by Crash Direction and Accident Year," May 1988; printed in Papers on Adult Seat Belts -- Effectiveness and Use, NHTSA, DOT-HS-807-285, June 1988). The comparisons by year do not suggest a pattern of large reporting effects on estimates of belt effectiveness in fatality prevention, when the estimates are produced by the matched pairs technique for fatal crashes. This technique used only the data available in fatal crashes. Estimates produced by comparing injury rates in towaway crashes by reported belt use would produce unrealistically high estimates of belt effectiveness because of misreporting in those crashes.

Based on this comparison, it seems that useful information on who uses belts in serious crashes can be gained from detailed analysis of the FARS data. Belt use in crashes varies widely with a variety of factors, including impact type and extent of damage. These differences have been considered in estimating the effectiveness of safety belts in preventing fatality. This report focuses on other differences between belted and unbelted drivers -- differences in the time and place of their crashes, the weight and age of their cars, and their personal characteristics (age, sex, and driver history) and alcohol use in the crashes. Most estimates presented here are based on 1987 and 1988 police reports of passenger car driver fatalities.

Method

Safety belt use by fatalities is lower than safety belt use by all those involved in serious crashes because belt use prevents fatality. As an extreme example, if a hypothetical safety device were 100 percent effective, there would be no fatalities using the device. If the device were 75 percent effective, there would be some fatalities with the device, but use among fatalities would be substantially less than among those who needed the device (those involved in serious crashes). If device use were high in blue cars and low in red cars, comparisons of device use by fatalities in red versus blue cars would understate the actual difference in device use in serious crashes by car color.

In order to more accurately gauge differences in belt use among those in life-threatening situations, belt use by car drivers killed in crashes was adjusted for the estimated number of lives saved by belts. Adjusting the data allows more meaningful comparisons of belt use among different drivers, vehicles, and situations. Fatality belt use, adjusted to reflect those who were belted and survived because of their belt use, is an estimate of the belt use of all those who would have been killed if no one had been belted. The number "at risk of fatality" was defined as the sum of those killed (both belted and unbelted) and those saved by safety belts (calculated from the estimated effectiveness of safety belts in preventing fatality). The belt use rate of those at risk of fatality is a simple transformation of the belt use rate of those actually killed. No adjustments were made for possible differences in belt effectiveness among different drivers, vehicles, and situations because the data to make such desirable adjustments are not available.

During 1987 and 1988, a total of 34,006 people were killed in crashes while driving a passenger car. About 87 percent of these cars were model years 1974 and later, and were required to have been manufactured with lap and shoulder belts in the driver's and right-front passenger's seats. The police recorded their determination of whether or not the safety belt was used for 26,784 of these driver fatalities. These 26,784 fatalities are the basis for this report. All data are from the FARS file. No adjustments were made to account for fatalities with unknown belt use or for fatalities in older cars. Detailed definitions of these terms are included in the Appendix.

According to the police,

6,191 of these fatalities were using a safety belt and
20,593 were unbelted.

Using a lap and shoulder belt reduces a person's risk of fatality by an estimated 40 to 50 percent. The midpoint of this range is 45 percent, and this is the estimate used to calculate the likely number of people who were saved by their safety belts.

As an example of the method used, assume that 100 people were belted and involved in crashes that would have killed unbelted people. Because safety belts are estimated to be 45 percent effective in preventing fatality,

45 people would be saved by their belts and
55 people would die despite using their belts.

The 55 hypothetical fatalities would die from massive intrusion into the car, from serious side impact damage, or from damage so severe that the belts could not fully protect the user against life-threatening injury. The 45 survivors would be saved because the design of the belt fit the crash situation. For each 55 people who died wearing a belt and were reported in FARS, an additional 45 people would have been saved by their belts. So, each belted fatality is an indication that

45 / 55 people survived because of belt use.

Applying this ratio to the 1987 and 1988 FARS data, the 6,191 belted fatalities represent

$$6{,}191 * (45 / 55) = 5{,}065 \text{ drivers}$$

who were saved by their lap and shoulder belt. The 26,784 fatalities that did occur plus the 5,065 estimated to have been saved imply that 31,849 fatalities would have occurred if no one had used the safety belts provided in the car.

In this report, the fatalities that would have occurred if there had been no belt use are called the "at-risk" group. In 1987 and 1988 combined,

$$\frac{6{,}191 + 5{,}065}{31{,}849} = \frac{11{,}256}{31{,}849} = 35.3 \text{ percent}$$

of drivers were belted in situations where they were at risk of fatality.

This report compares the belt use of passenger car drivers at risk of fatality, for various situations, vehicles, and drivers. Each table in the main text was produced from two tables in the Appendix. For example, Table A-1a (in the Appendix) shows the number of people who were killed in crashes in 1987 and 1988 (combined) while driving a car equipped with lap and shoulder belts and who were reported by the police to have been using their belts at the time of the crash. the corresonding counts of unbelted car driver fatalities are shown in Table A-1b. The data in these two tables were used to estimate the restraint use of drivers at risk of fatality, using the method outlined above. The results are shown in Table 1 in the main text.

The effects of identified differences between belted and unbelted drivers were evaluated by statistically adjusting the data or by estimating belt effectiveness on a subset of the data. The statistical adjustments for crash speed were done by reweighting the NCSS data to the crash speed distribution of the combined experience of belted and unbelted drivers. The FARS subset analysis (on young adults, people who had been drinking, and people who had not been drinking) was performed using the matched-pairs analysis technique (described by L. Evans in "Double Pair Comparison -- A New Method to Determine How Occupant Characteristics Affect Fatality Risk in Traffic Crashes," Accident Analysis and Prevention, Volume 18, Number 3, June 1986).

Differences Between Belt Users and Nonusers

Crash Time and Place

Findings: Belt use was lower at night and on weekends (largely because weekend crashes tended to occur at night). Belt use was higher on higher speed roads, but lower among drivers reported to have been speeding.

Table 1 shows that belt use among those at risk of fatality was highest during the day. In the hour just before noon, an estimated 48.5 percent were belted. In contrast, in the hour just after midnight, the use rate was less than half that high (only 21.7 percent). The data are plotted as Figure 1a.

Belt use was substantially lower on weekends than on weekdays. An estimated 39.5 percent were belted on Monday, compared to 30.8 percent on Saturday. However, Figure 1b shows that the lower weekend belt use largely reflects the larger proportion of weekend fatalities that occur during nighttime hours, when belt use is lowest. Controlling for the hour of the day, belt use does not vary nearly as much by day of week.

Table 1: Of Drivers at Risk of Fatality, Estimated Percent Belted -- by Day of Week and Hour of Day

Hour	Day of Week							
Beginning	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Midnight	20.9	26.7	25.4	26.7	17.1	22.0	19.8	21.7
1 AM	24.9	23.0	21.0	11.4	27.6	22.5	22.3	22.8
2 AM	19.0	28.2	25.5	19.4	17.1	20.3	24.7	21.9
3 AM	15.8	13.0	29.4	25.3	20.1	15.5	22.4	19.8
4 AM	22.5	20.6	26.1	26.7	22.9	18.7	18.7	21.4
5 AM	22.1	31.3	28.3	49.5	36.8	23.0	29.9	30.3
6 AM	29.3	43.8	27.9	40.2	43.5	44.3	21.5	35.7
7 AM	31.8	48.7	42.6	42.6	44.7	40.0	40.4	42.4
8 AM	32.4	44.3	54.0	43.0	45.3	51.4	32.4	44.5
9 AM	47.2	50.6	51.3	40.2	43.4	44.7	50.9	47.1
10 AM	37.4	40.7	41.8	46.1	49.9	54.6	54.0	46.8
11 AM	45.5	52.9	45.6	55.4	43.9	45.0	51.2	48.5
Noon	42.3	49.8	47.3	46.3	46.1	45.4	44.4	46.0
1 PM	46.3	50.9	46.9	50.7	43.4	44.1	35.4	45.5
2 PM	42.1	43.3	40.3	45.6	49.3	48.4	44.0	44.8
3 PM	45.5	43.4	48.5	47.6	46.3	40.6	37.9	44.2
4 PM	48.4	48.9	45.0	41.0	45.5	45.7	36.1	44.4
5 PM	42.7	42.8	45.1	45.3	41.5	39.9	34.5	41.4
6 PM	37.4	44.3	40.2	31.9	31.5	39.4	34.8	36.7
7 PM	29.7	30.4	35.9	32.6	32.0	44.2	31.1	34.3
8 PM	32.2	24.7	31.1	32.5	31.7	32.4	27.0	30.4
9 PM	26.2	25.4	26.8	30.4	30.6	31.8	28.0	28.9
10 PM	31.1	33.5	24.0	35.6	29.9	29.1	28.3	30.2
11 PM	29.1	27.6	22.0	23.8	26.0	19.1	26.7	24.4
Unknown	18.9	34.2	26.7	28.8	32.2	13.5	14.8	21.7
Total	31.3	39.5	38.6	38.1	36.6	36.0	30.8	35.3

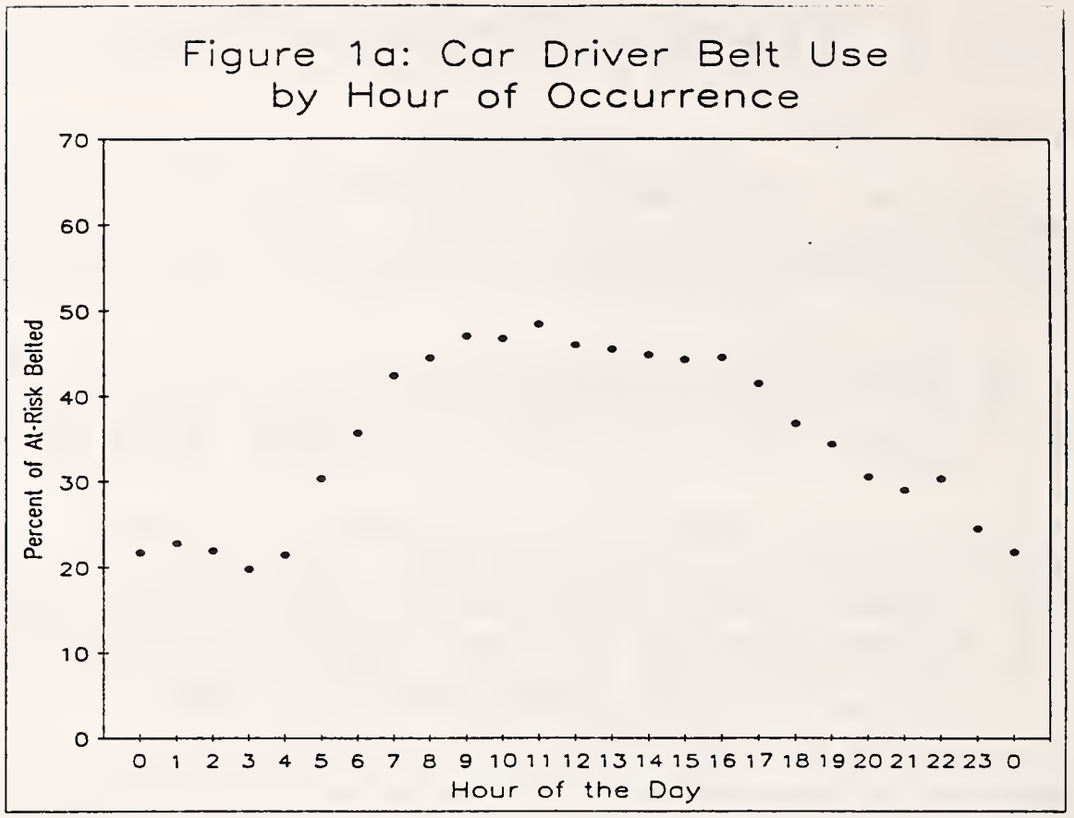


Figure 1a: Car Driver Belt Use
by Hour of Occurrence
Percent of At-Risk Belted
0
10
20
30
40
50
60
70
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Hour of the Day

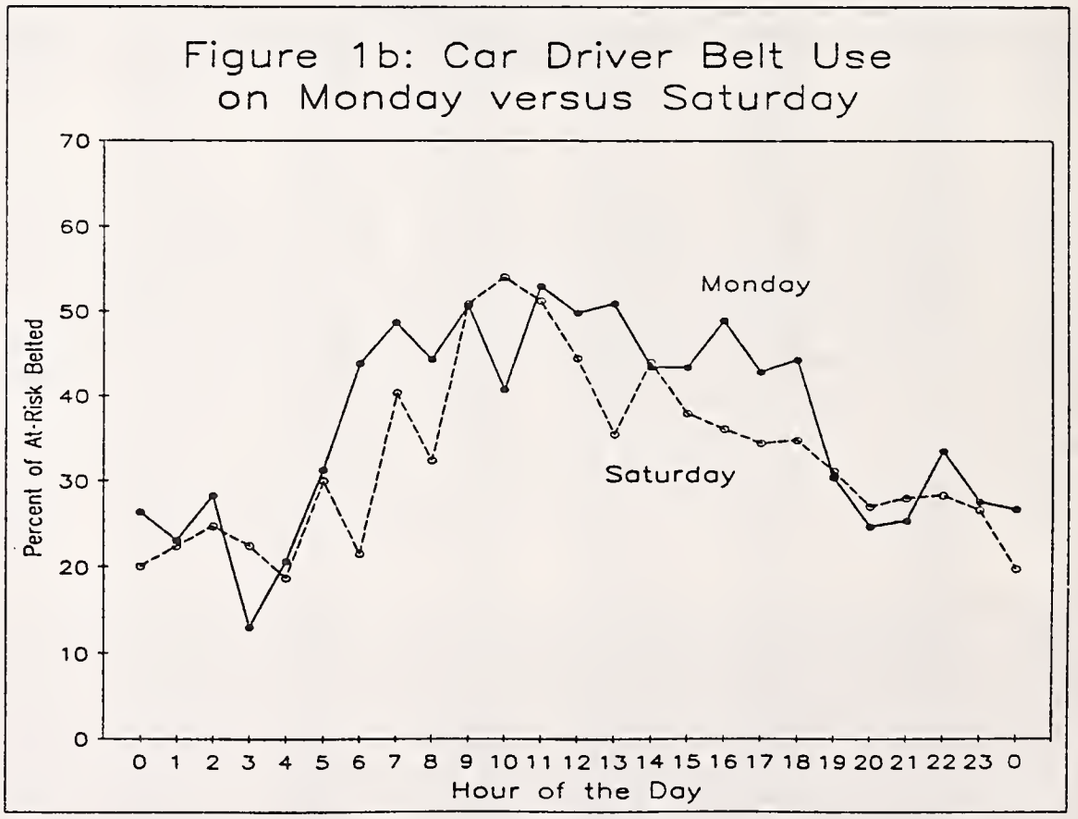


Figure 1b: Car Driver Belt Use
on Monday versus Saturday
Percent of At-Risk Belted
0
10
20
30
40
50
60
70
Monday
Saturday
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 0
Hour of the Day

Table 2 shows that belt use was higher on roads with higher speed limits. Only 30.1 percent of those at risk of fatality were belted when traveling on roads with speed limits of 25 mph and lower, but 38.1 percent of those on 60 and 65 mph roads were belted. The data are plotted as Figure 2a.

The police recorded an estimated travel speed for 42 percent of the fatalities. The speed limit and the travel speed can be used to estimate that 46.7 percent of drivers who were traveling at least ten mph below the speed limit were belted. A smaller proportion of those traveling within nine mph of the speed limit (37.4 percent) were belted. But substantially fewer (between 18.6 and 23.8 percent) of those estimated to have been traveling ten mph or more over the speed limit were reported by the police to have been using a belt at the time of the crash. The data are plotted in Figure 2b. Note that because of coding limitations (in FARS, travel speeds above 96 mph are collapsed into the category "97 mph and above"), it is not possible to determine that a driver on a 60 mph road was traveling 40 mph or more over the limit. Speeding by more than 37 mph on a 60 mph road, or by more than 32 mph on a 65 mph road, have been included in the category "more than 39" mph over the speed limit in this table.

It is not known to what extent police form an overall assessment of the likelihood of illegal or risky driver behaviors before estimating travel speed and belt use. To the extent that they do make overall assessments, the actual correlation between travel speed and belt use may be exaggerated in these data.

The extent to which a driver was exceeding the speed limit appears to be a better indication of his belt use than is the speed limit. The lowest estimated belt use occurred on roads with speed limits under 30 mph, and the highest belt use was estimated for roads with speed limits over 55 mph. However, Figure 2c shows that controlling for relative speed (travel speed relative to the speed limit), there was no difference in belt use by speed limit. The greater belt use on higher speed roads appears to be accounted for by the greater likelihood that a fatally-injured driver was traveling under or near the speed limit on higher speed roads. Low speed roads appear to be relatively safe unless the driver was speeding or taking other unusual risks.

Table 2: Of Drivers at Risk of Fatality, Estimated Percent Belted -- by Speed Limit and Estimated Travel Speed

	Miles per Hour by which Travel Speed Exceeds Speed Limit							
Speed Limit	Slower Travel	Near Limit	Over by 10-19	Over by 20-29	Over by 30-39	More than 39	Unknown	Total
<30 mph	44.7	40.7	27.4	27.8	22.7	11.0	29.9	30.1
30 mph	47.1	29.4	24.8	15.6	23.9	25.4	32.4	31.6
35 mph	55.8	41.9	25.0	16.3	12.9	16.7	31.6	32.5
40 mph	43.1	37.6	27.9	26.2	28.8	16.4	39.2	37.6
45 mph	54.0	38.0	27.7	14.7	23.7	27.1	36.8	37.1
50 mph	47.9	28.3	25.4	8.5	19.9	31.3	38.0	36.4
55 mph	44.0	37.1	21.8	19.6	16.1	15.5	37.5	35.7
>55 mph	41.7	40.9	29.2	27.3	25.4	-	37.9	38.1
Unknown	-	-	-	-	-	-	30.6	30.6
Total	46.7	37.4	23.8	18.9	19.0	18.6	36.2	35.3

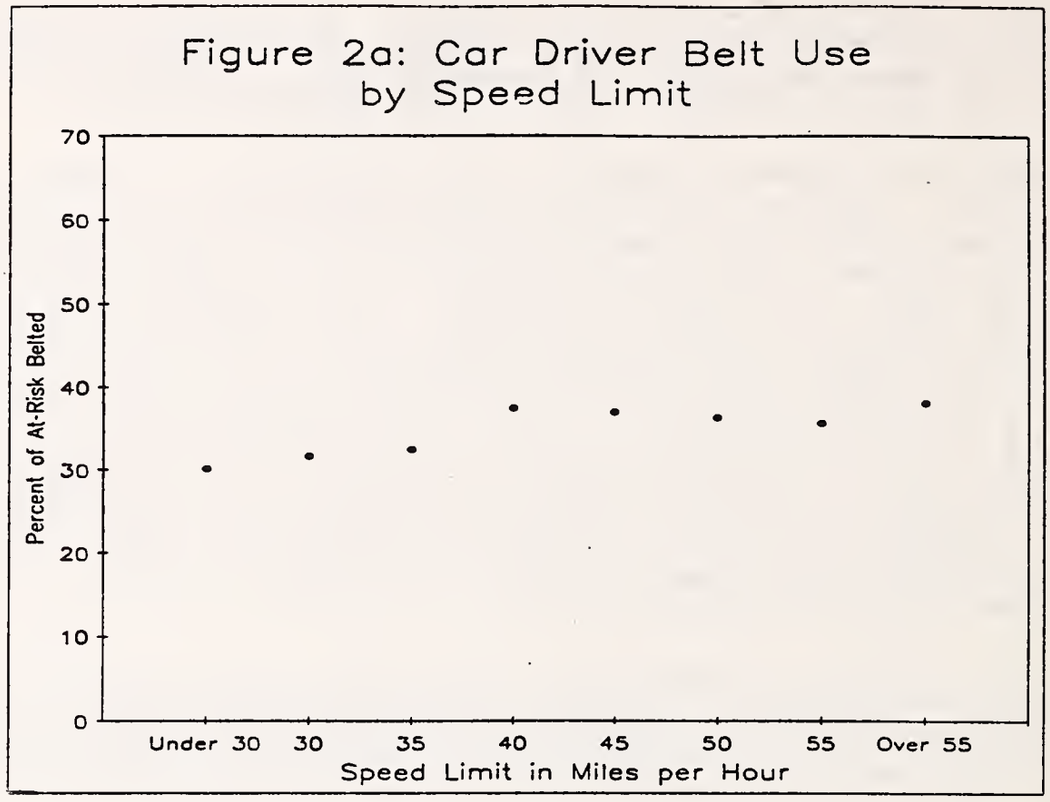


Figure 2a: Car Driver Belt Use
by Speed Limit
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Under 30
30
35
40
45
50
55
Over 55
Speed Limit in Miles per Hour

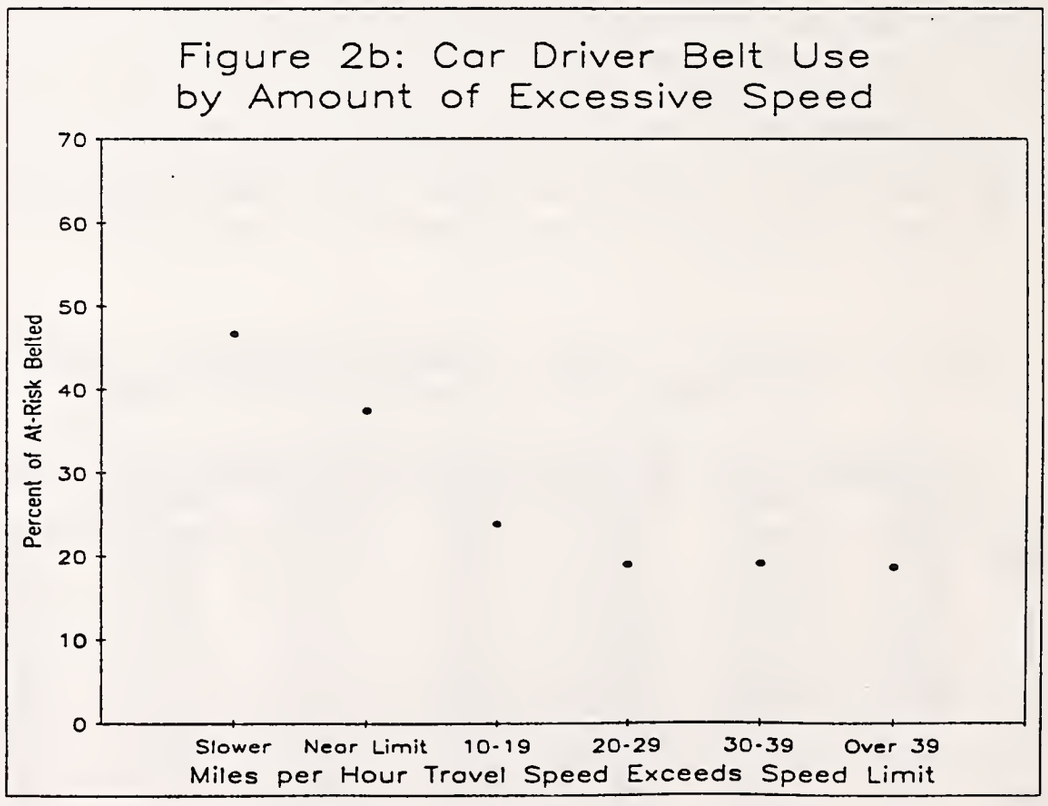


Figure 2b: Car Driver Belt Use
by Amount of Excessive Speed
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Slower
Near Limit
10-19
20-29
30-39
Over 39
Miles per Hour Travel Speed Exceeds Speed Limit

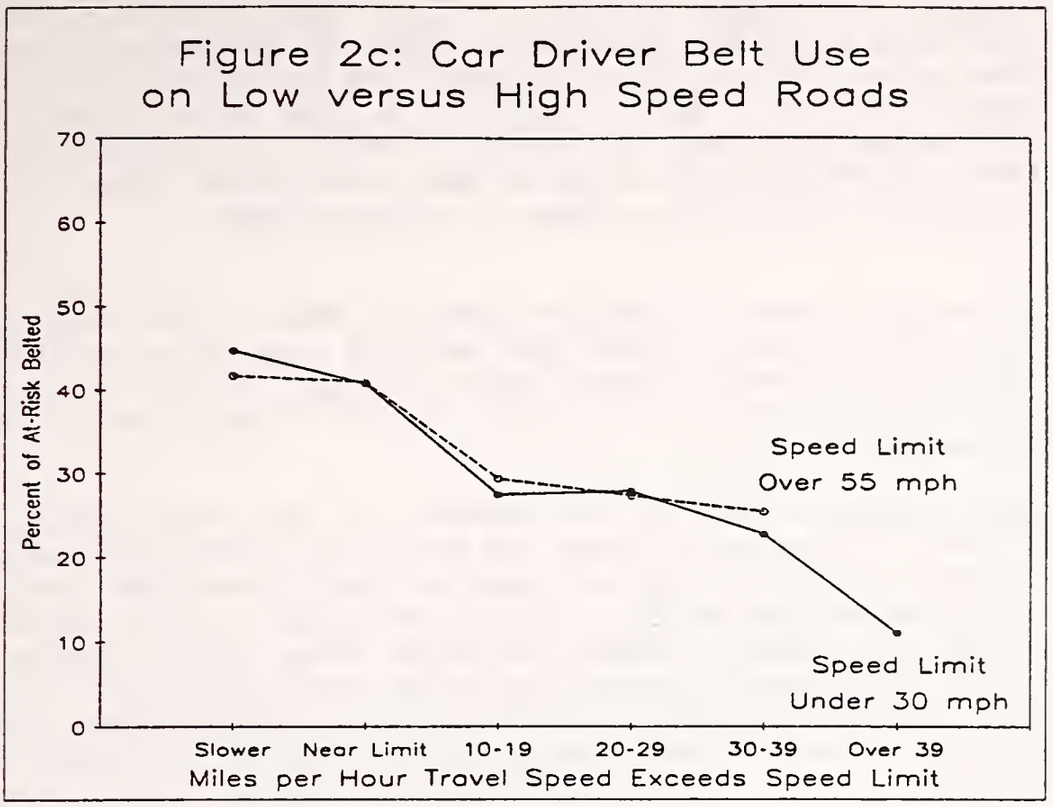


Figure 2c: Car Driver Belt Use
on Low versus High Speed Roads
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Speed Limit
Over 55 mph
Speed Limit
Under 30 mph
Slower
Near Limit
10-19
20-29
30-39
Over 39
Miles per Hour Travel Speed Exceeds Speed Limit

Vehicle Weight, Vehicle Age, and Driver Age

Findings: Car weight, car age, and driver age are interrelated and so must be studied together. Belt use was higher in lighter cars, primarily because belt use was higher in newer cars and lighter cars tended to be newer than heavier cars. A review of earlier years of data indicates that this tendency reflects differences in vehicle use as vehicles age, rather than improved belt use design in more recent model years. Within car age categories, belt use was higher for older drivers.

Car weight classes were defined from the vehicle curb weight, as described in the Appendix. Table 3 shows that belt use among those at risk of fatality was higher for drivers of lighter cars. The data are plotted in Figure 3a. The data also show that belt use was higher for older drivers. These data are plotted as Figure 3b.

People killed in heavier cars tended to be older than people killed in lighter cars. As a result, these two tendencies (lower belt use rates in heavier cars and higher belt use rates by older drivers) are partially hidden in studying either car weight or driver age alone. Figures 3c and 3d illustrate the tendencies within car weight class (controlling for driver age) and driver age category (controlling for car weight). Within each driver age category, belt use decreased with increasing car weight class (Figure 3c); within each car weight class, belt use increased with increasing driver age (Figure 3d).

Table 3: Of Drivers at Risk of Fatality, Estimated Percent Belted -- by Car Weight Class and Driver Age

	Car Weight Class							
Driver Age	Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
10-14	0.0	18.5	13.2	15.4	0.0	0.0	0.0	10.2
15-19	34.2	30.7	28.5	23.6	21.5	11.0	30.6	28.3
20-24	31.3	32.0	29.1	16.9	16.1	11.9	27.8	26.4
25-29	35.8	32.0	29.9	23.7	19.2	12.2	31.0	28.6
30-34	32.0	35.8	36.9	27.5	17.9	10.8	31.7	31.2
35-39	34.8	33.5	37.6	31.2	26.4	18.2	41.5	33.3
40-44	37.7	42.8	40.9	35.3	26.3	21.1	31.0	36.7
45-49	31.3	46.1	41.7	38.0	29.6	20.0	39.8	39.0
50-54	40.8	46.8	48.6	38.0	30.6	20.4	47.6	41.3
55-59	48.3	44.9	49.0	42.9	39.2	24.8	57.7	44.2
60-64	36.2	44.3	50.1	42.8	40.6	37.3	46.9	43.9
65-69	59.8	54.1	51.8	47.8	46.7	30.9	56.5	49.8
70-74	52.8	54.5	63.5	53.8	51.1	32.4	39.8	54.0
75-79	54.8	57.2	58.9	49.2	50.0	49.5	47.6	53.6
80-84	64.5	54.6	65.8	54.1	49.7	51.0	59.6	56.8
85-89	56.5	50.4	43.0	49.2	48.8	42.1	16.8	46.9
90-94	0.0	12.3	68.6	42.1	73.2	26.7	-	43.1
Over 94	-	0.0	0.0	100.0	100.0	0.0	-	37.7
Unknown	0.0	0.0	0.0	0.0	64.5	0.0	0.0	9.7
Total	35.8	37.7	38.8	32.6	30.8	22.9	36.0	35.3

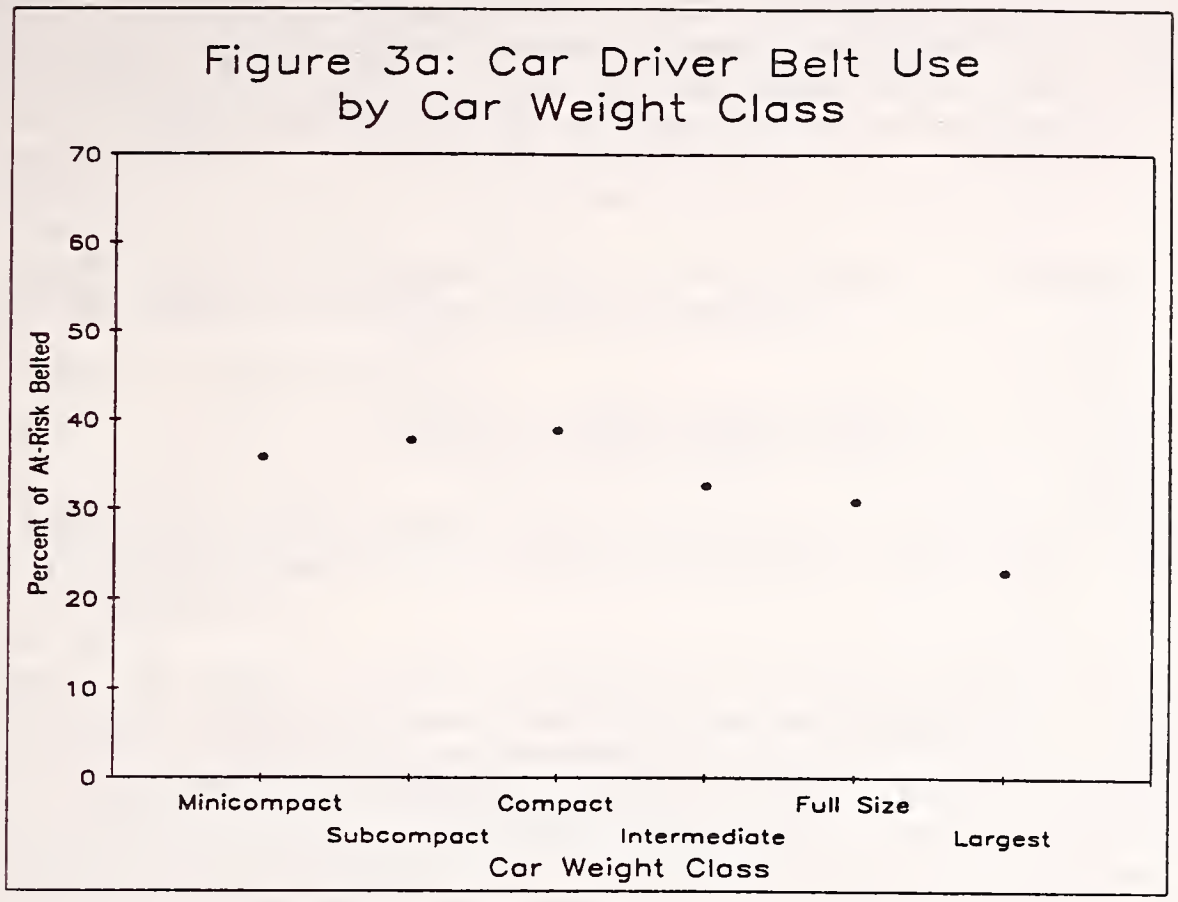


Figure 3a: Car Driver Belt Use
by Car Weight Class
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Minicompact
Subcompact
Compact
Intermediate
Full Size
Largest
Car Weight Class

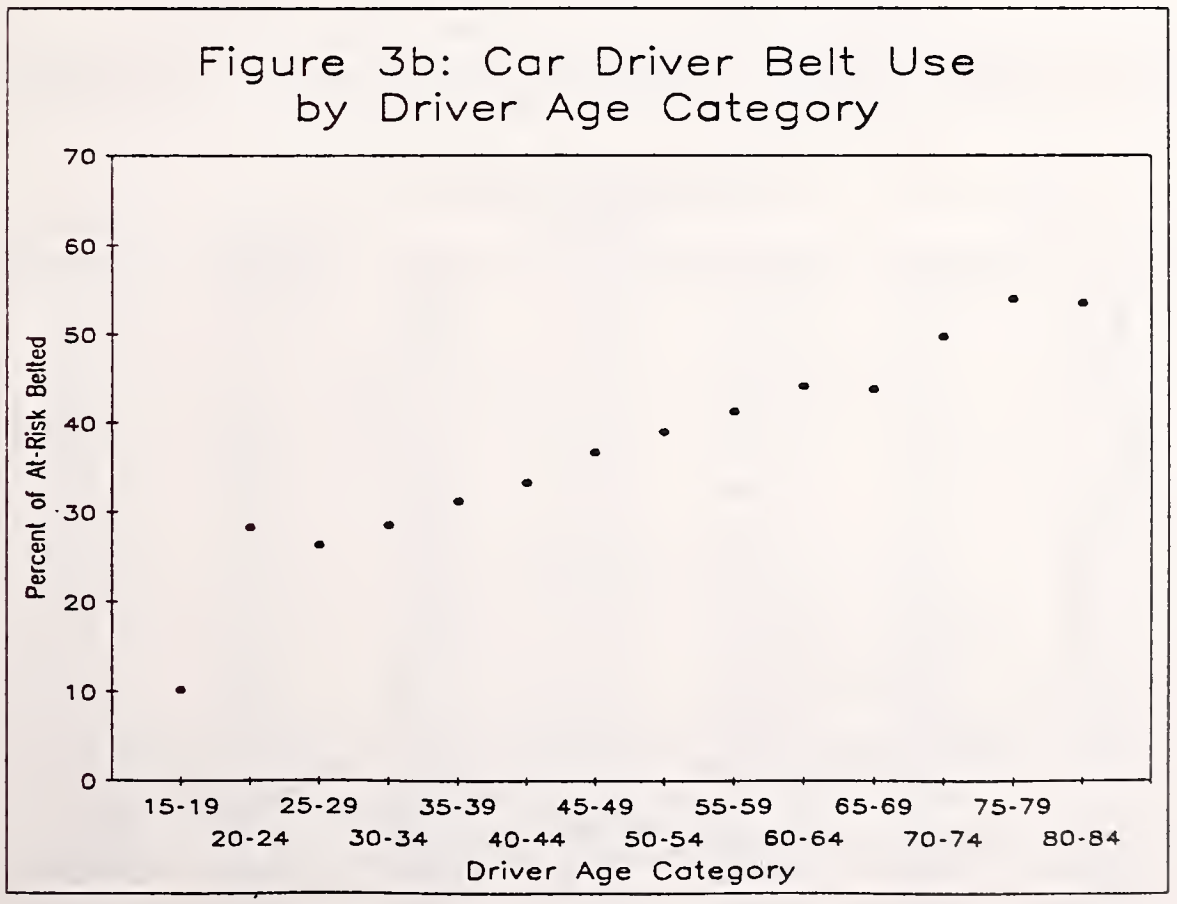


Figure 3b: Car Driver Belt Use
by Driver Age Category
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
Driver Age Category

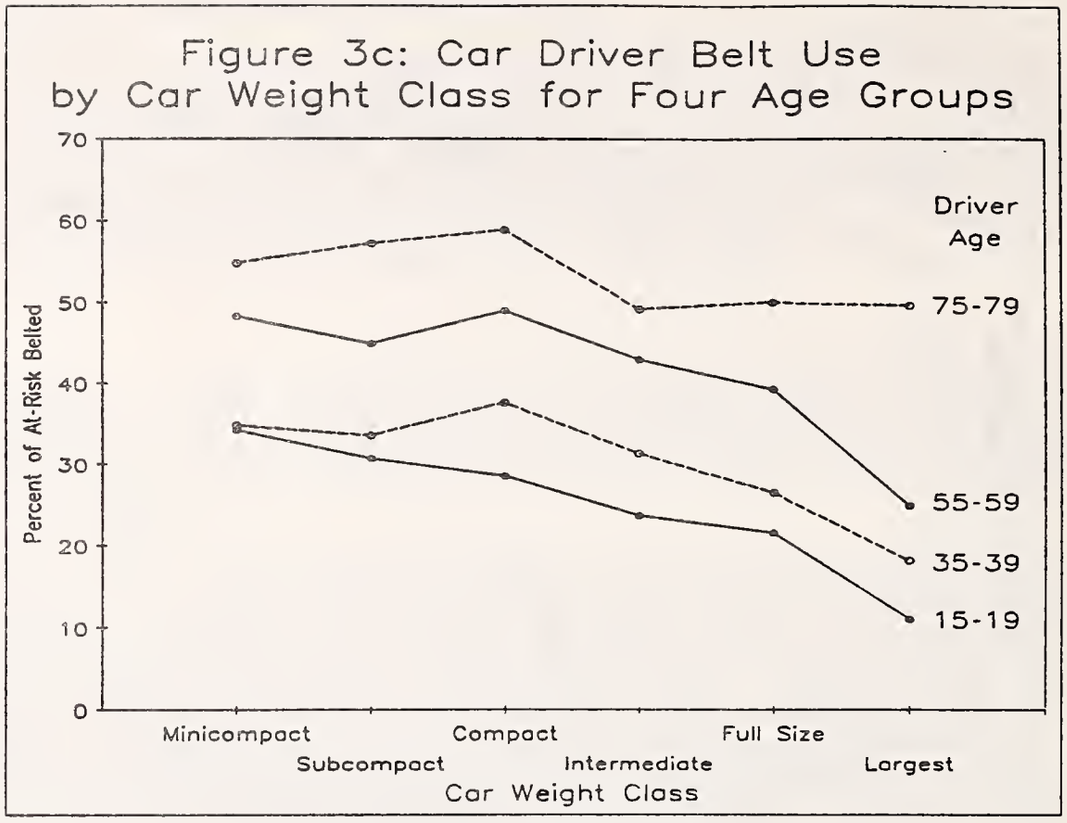


Figure 3c: Car Driver Belt Use
by Car Weight Class for Four Age Groups
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Driver
Age
75-79
55-59
35-39
15-19
Minicompact
Subcompact
Compact
Intermediate
Full Size
Largest
Car Weight Class

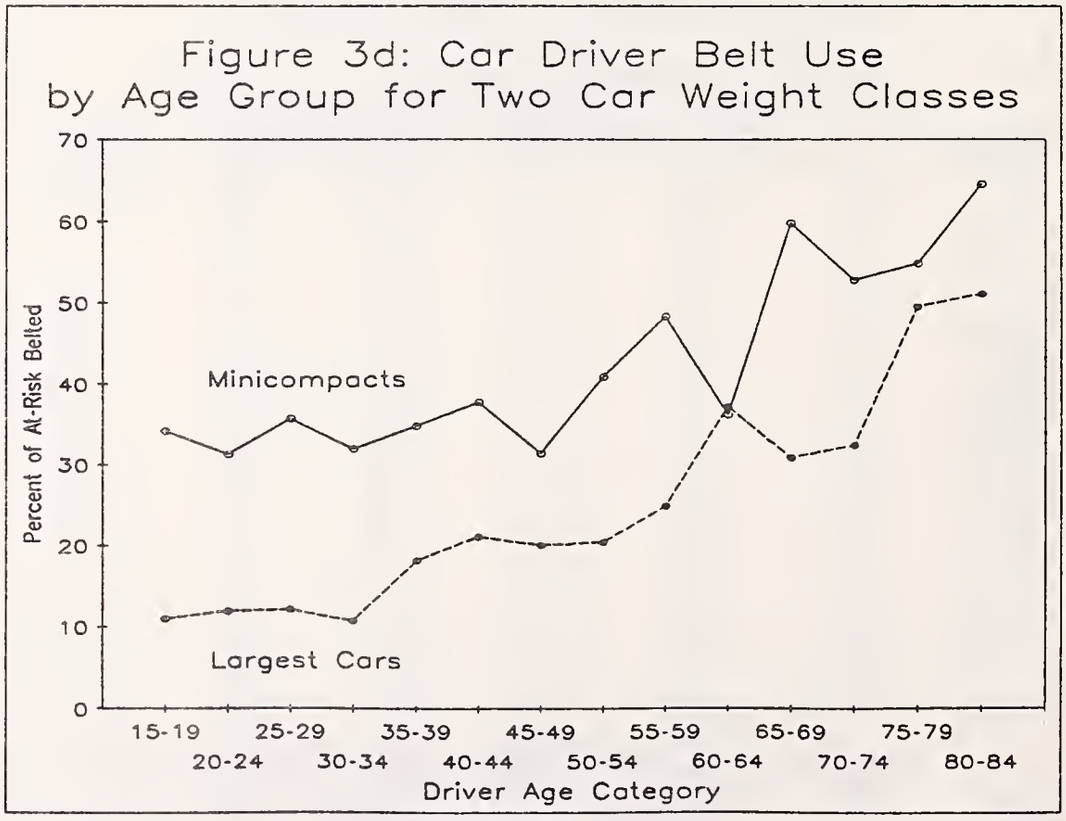


Figure 3d: Car Driver Belt Use
by Age Group for Two Car Weight Classes
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Minicompacts
Largest Cars
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
Driver Age Category

Car weight and driver age can be considered simultaneously in a linear regression. For this purpose, the data were restricted to drivers in cars with known weight. Only drivers between 15 and 84 years old were used in the analysis because of the small numbers of younger and older drivers. For the model, each category was represented by the midpoint of each factor. Car weight was represented in hundreds of pounds (19, 22, 27, 32, 37, 42) for the six classes.

The least-squares fit through the 84 data points has an R-squared value of 0.86 (with 81 degrees of freedom) with the equation:

Percent belted = 34.60027
+ 0.53399 * Driver age in years
- 0.77800 * Car weight in hundreds of pounds.

Each of the explanatory variables adds significantly to the fit of the equation. The model describes the higher belt use by older drivers and by drivers of lighter cars.

However, the results in Table 4 imply that car weight does not in itself affect belt use. Figure 4a shows that belt use decreased with car age (calculated as the difference between the crash year and the model year) during 1987 and 1988. And Figure 4b shows that this trend was very similar for compact cars (with the highest belt use of the six weight classes, 38.3 percent) and for the largest cars (with the lowest belt use, 22.9 percent). It appears that lighter cars have higher belt use rates because, in recent years, they tend to be newer than heavier cars. It does not appear, from these data, that drivers in lighter cars used belts to compensate for the greater risk to occupants of lighter cars.

Table 4: Of Drivers at Risk of Fatality, Estimated Percent Belted
-- by Car Weight Class and Car Age

	Car Weight Class							
Car Age	Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
New	47.6	54.8	33.8	43.1	0.0	37.7	42.1	42.1
0	36.9	43.2	46.7	39.5	52.2	56.2	35.1	42.7
1	43.1	43.6	47.2	43.1	52.2	57.7	38.2	44.6
2	40.7	47.2	42.8	47.0	47.6	32.2	39.0	44.7
3	46.0	43.0	46.6	38.7	46.2	39.8	43.9	43.7
4	46.0	41.4	43.4	33.7	48.2	47.6	51.3	42.9
5	36.4	38.5	40.4	43.5	45.2	52.2	48.3	40.9
6	39.7	33.0	40.4	31.8	42.0	64.5	40.3	36.4
7	33.4	31.1	30.4	33.2	38.1	15.4	18.7	31.5
8	36.7	32.5	26.8	26.4	22.9	37.7	18.8	28.8
9	28.7	24.0	26.4	25.1	28.5	22.7	27.0	25.8
10	22.6	22.0	21.5	24.4	21.2	22.2	13.8	22.4
11	18.2	22.1	17.3	22.3	16.4	21.4	9.0	18.9
12	19.8	28.0	11.9	23.3	16.4	14.6	17.2	18.0
13	26.7	24.2	21.8	11.2	13.5	10.0	8.0	15.4
14	20.6	7.8	30.1	23.6	17.0	14.0	11.5	18.4
Total	35.8	37.7	38.8	32.6	30.8	22.9	36.0	35.3

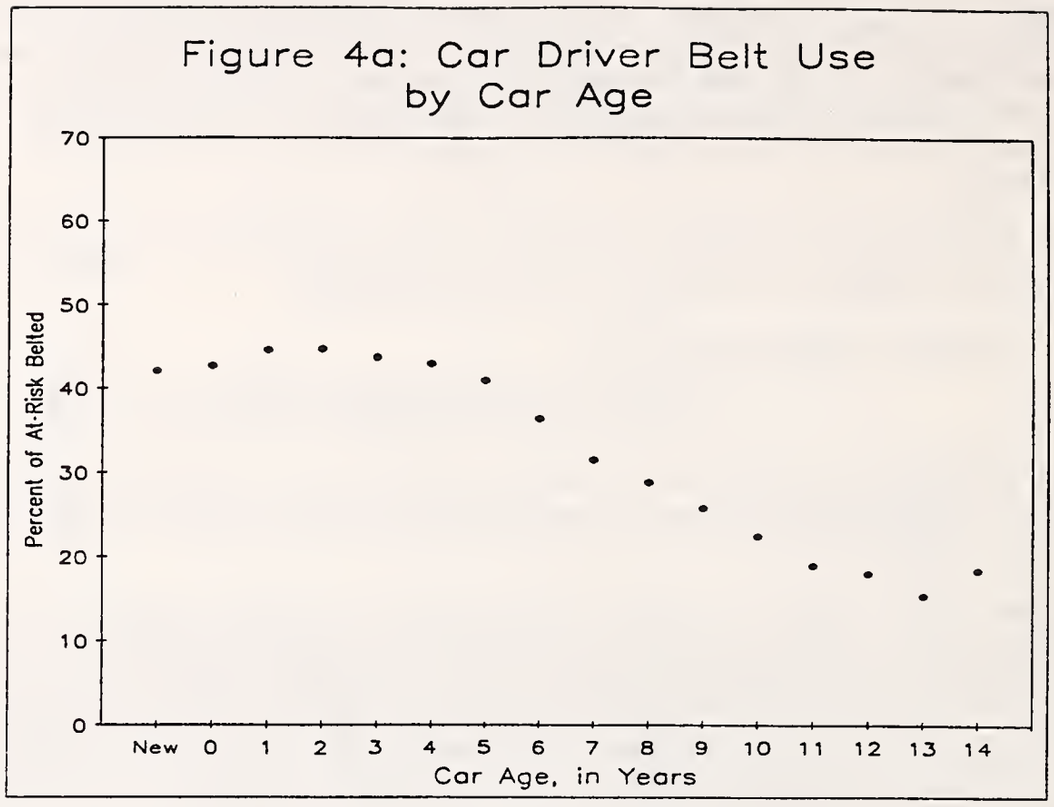


Figure 4a: Car Driver Belt Use
by Car Age
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
New 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Car Age, in Years

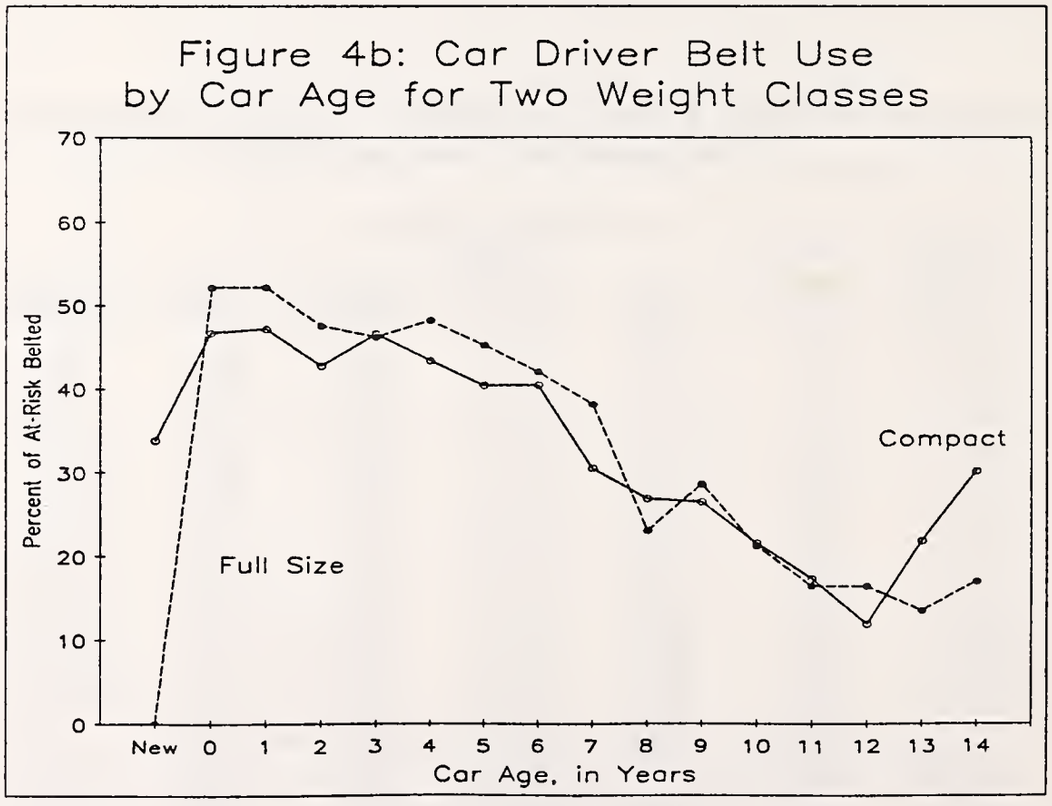


Figure 4b: Car Driver Belt Use
by Car Age for Two Weight Classes
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Compact
Full Size
New 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
Car Age, in Years

To model the effects of car age and car weight, some categories of data with a small number of observations were eliminated. If the model year was later than the crash year (for example, 1985 model year cars in crash year 1984) or if the car was over eleven years old (for example, 1974 model year cars in crash year 1986), the category was eliminated. The data were restricted to cars between zero and eleven years old. A least-squares fit through the 72 data points has an R-squared value of 0.65 (with 70 degrees of freedom) with the equation:

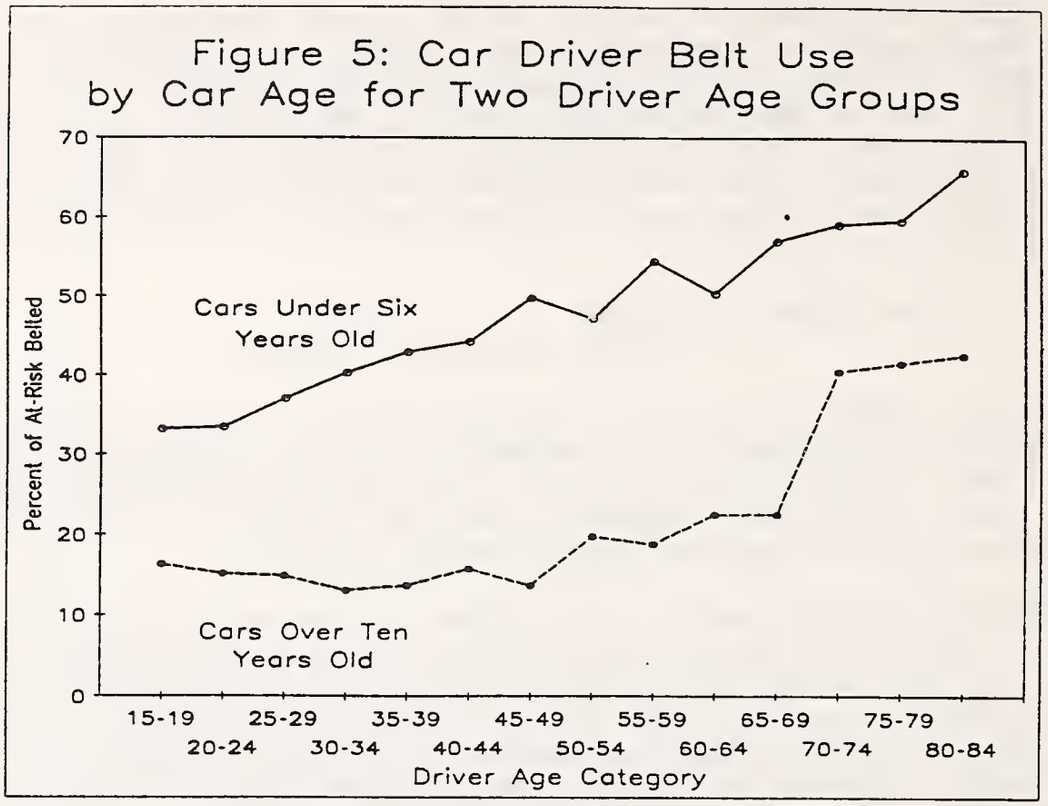
Percent belted = 50.63291
- 2.59129 * Car age in years.

This equation implies that about 51 percent of new car drivers were belted, and that belt use dropped by 2.6 percentage points for each year the car was on the road. The model is not significantly improved by the addition of a term for car weight class, indicating that car weight does not explain differences in belt use after controlling for car age.

The data for belt use by car age shown in Table 4a suggest that belt use was fairly stable for cars up to five years old, decreased rapidly through the tenth year, and then was fairly stable for older cars. Table 5 shows belt use by driver age and car age, with car age collapsed into categories for cars under six years old and for cars over ten years old, to simplify the presentation. As shown in Figure 5, belt use among those at risk of fatality was greatest in the newest cars and increased with increasing driver age.

Table 5: Of Drivers at Risk of Fatality, Estimated Percent Belted
-- Driver Age and Car Age

Driver	Car Age, in Years							
Age	Under 6	Six	Seven	Eight	Nine	Ten	Over 10	Total
10-14	8.7	47.6	100.0	0.0	0.0	0.0	0.0	10.2
15-19	33.2	30.5	25.1	26.9	27.6	21.6	16.3	28.3
20-24	33.5	28.4	22.1	20.1	18.8	14.1	15.2	26.4
25-29	37.1	34.2	20.5	19.0	18.3	16.9	14.9	28.6
30-34	40.3	38.5	33.3	19.4	13.7	20.5	13.1	31.2
35-39	42.9	28.2	33.0	30.5	20.2	11.0	13.7	33.3
40-44	44.2	36.7	28.8	31.7	29.8	27.9	15.8	36.7
45-49	49.8	35.3	25.3	30.3	14.7	27.6	13.7	39.0
50-54	47.2	45.5	41.5	42.3	31.6	24.6	19.8	41.3
55-59	52.5	50.4	32.7	30.2	38.5	27.1	18.8	44.2
60-64	50.4	36.1	50.3	33.0	36.9	30.1	22.4	43.9
65-69	57.0	50.2	44.0	50.1	39.9	25.6	22.5	49.8
70-74	59.1	49.9	54.8	47.6	49.8	31.7	40.4	54.0
75-79	59.6	43.2	51.0	48.2	46.5	42.1	41.5	53.6
80-84	65.9	64.5	54.1	43.8	34.5	40.5	42.5	56.8
85-89	49.0	45.2	55.7	59.3	37.7	57.1	22.1	46.9
90-94	49.2	47.6	0.0	47.6	54.8	47.6	20.6	43.1
Over 94	78.4	0.0	0.0	-	0.0	-	0.0	37.7
Unknown	20.6	0.0	-	0.0	0.0	-	0.0	9.7
Total	43.4	36.4	31.5	28.8	25.8	22.4	17.9	35.3



A line was fit through the data for 15 through 84 year old drivers, using "5" for cars newer than six years and "11" for cars older than ten years. The model through the 98 data points has an R-squared value of 0.81 (with 95 degrees of freedom) with the equation:

Percent belted = 42.82623
+ 0.42913 * Driver age in years
- 3.70083 * Car age in years.

In 1987 and 1988, belt use increased 4.3 percent for each ten-year increase in driver age and decreased 3.7 percent for each one-year increase in car age.

It is not clear why belt use was lower in older vehicles in 1987 and 1988. One possibility is that belt use decreased with car age because belts become too dirty to use or because people who drove newer cars wanted to use all the new features. Another possibility is that belt use was lower in older cars because belt designs have improved in more-recent cars. There are fourteen years of FARS data available to test these possibilities by studying belt use over time and across model year.

Table 6 shows that belt use was below ten percent from 1975 through 1984. Only in 1985, after states began passing and implementing belt use laws, did belt use rise substantially (to 19.8 percent among those at risk of fatality). From crash year 1975 through 1984, the highest belt use was estimated for 1974 model year cars in crash year 1975 (20.6 percent of those at risk of fatality). These vehicles were equipped with an ignition interlock that prevented the driver from starting the car without buckling his safety belt. Many of the interlocks were later disconnected by their owners.

Table 6: Of Drivers at Risk of Fatality, Estimated Percent Belted — by Crash Year and Car Model Year

Model	Crash Year														
Year	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
1974	20.6	12.6	12.4	7.2	5.0	5.3	4.1	2.9	5.6	3.6	9.1	15.8	16.0	18.4	9.4
1975	18.3	10.3	6.7	6.0	5.8	4.0	3.6	4.8	2.7	3.8	12.7	14.1	11.5	14.6	7.8
1976	8.9	11.6	10.3	8.6	5.5	3.6	3.5	6.7	5.6	6.0	9.3	16.0	18.7	22.4	9.0
1977		9.4	10.8	7.8	5.2	7.3	5.0	5.4	6.0	7.4	14.6	17.0	19.3	19.1	10.0
1978			9.3	7.7	7.1	7.3	6.1	4.1	6.3	7.3	15.1	21.8	24.3	24.8	11.7
1979				15.0	8.2	7.6	6.1	5.6	8.1	9.6	16.6	21.1	26.9	27.2	13.4
1980					7.0	7.5	8.9	9.0	8.4	10.1	18.6	28.4	31.4	30.6	17.0
1981						5.2	8.5	8.5	7.9	13.3	22.5	30.6	33.3	31.6	19.8
1982							6.7	10.2	8.1	10.9	23.0	35.7	38.9	39.6	24.6
1983								6.1	14.9	14.6	25.6	38.7	42.5	42.9	30.6
1984									3.3	17.1	26.4	37.4	42.0	43.2	33.9
1985										16.8	30.0	38.3	41.7	45.3	39.3
1986											30.7	38.0	42.8	47.4	43.1
1987												41.4	41.1	46.4	44.0
1988													27.1	44.3	43.4
1989	—	—	—	—	—	—	—	—	—	—	—	—	—	56.3	56.3
Total	19.6	11.6	10.2	7.6	6.2	6.3	5.9	6.4	7.5	9.9	19.8	28.9	33.7	36.9	18.2

Figure 6a shows that the belt use increases that began in 1985 occurred within car model year. That is, the effect was not primarily the result of the introduction of newer model years. Instead, the effect was an increase in belt use among drivers of cars of all model years. While belt systems that were easier to use may have contributed to the increase, most of the increase appears to have resulted from increased use of existing belts.

From 1975 to 1984, belt use was uniformly low. Consequently, it appears that the counfounding of crash year (and so general belt use trends) with car age does not greatly bias comparisons of belt use by car age in these years. The average belt use by car age from 1975 through 1984 was:

Car Age	Percent Belted
0	11.47
1	10.38
2	8.26
3	8.08
4	6.27
5	5.63
6	5.79
7	5.49
8	3.91
9	4.67
10	3.56

These data are plotted in Figure 6b, along with the data on car age estimated from the 1987 and 1988 data (from Figure 4a).

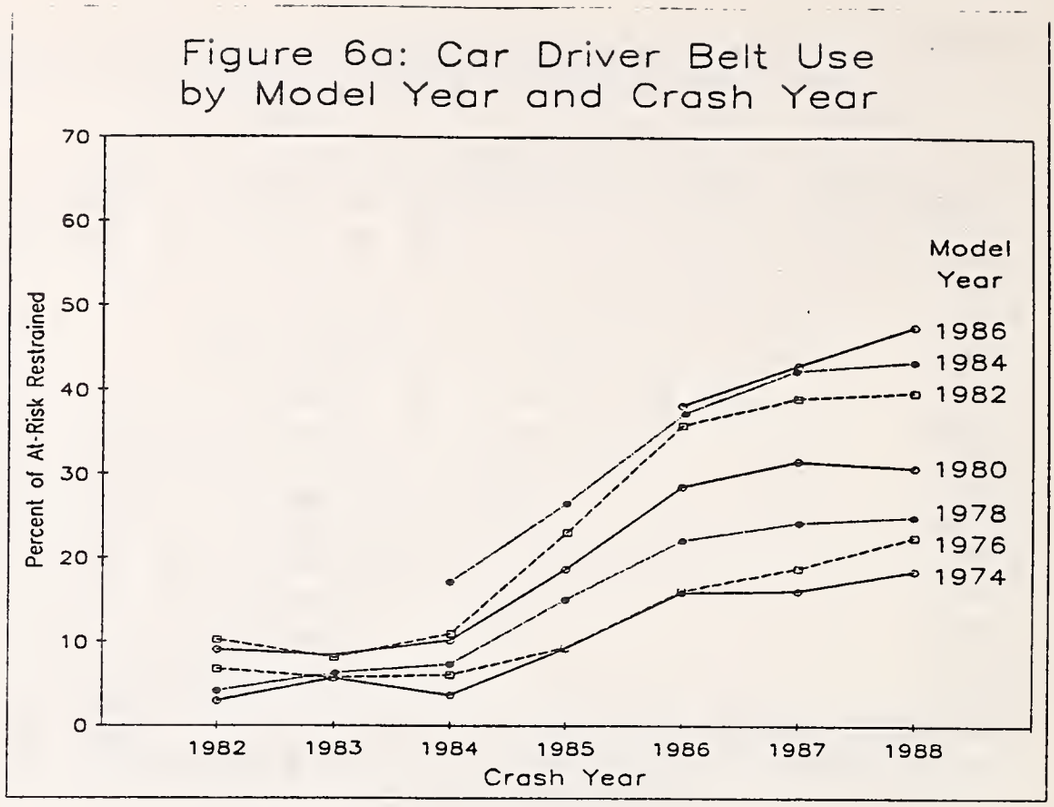


Figure 6a: Car Driver Belt Use
by Model Year and Crash Year
Percent of At-Risk Restrained
70
60
50
40
30
20
10
0
1982
1983
1984
1985
1986
1987
1988
Crash Year
Model
Year
1986
1984
1982
1980
1978
1976
1974

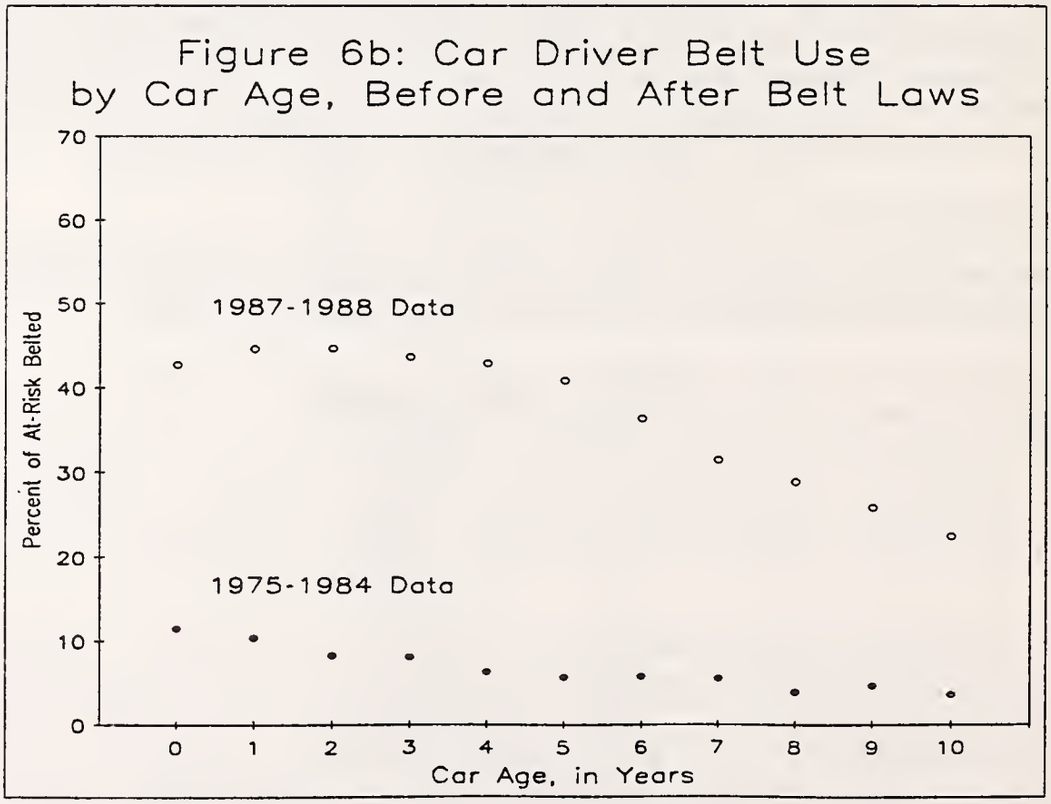


Figure 6b: Car Driver Belt Use
by Car Age, Before and After Belt Laws
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
1987-1988 Data
1975-1984 Data
0
1
2
3
4
5
6
7
8
9
10
Car Age, in Years

The data show that belt use was lower in older cars, both in the earlier period (1975 through 1984, with little trend in safety belt use) and in the later period (1987 and 1988, after rapid increases in belt use). In the older data with lower belt use, belt use dropped an average 0.79 percent per year as cars aged from new to ten years old. This drop was much less than the drop estimated from the 1987 and 1988 data, but belt use had much less room to drop in the earlier period because belt use was low even in new cars.

A model was fit through the 40 categories representing 1974 through 1980 model year cars that were between zero and five years old during 1975 through 1984, using car age and six dummy variables for model year. The line through the 40 data points has an R-squared value of 0.51 (with 32 degrees of freedom) with the equation:

```
Percent belted =  9.90744
                - 1.19583 * Car age in years
                + 5.24157 [if model year 1974]
                + 1.59811 [if model year 1975]
                + 0.25177 [if model year 1976]
                - 0.00113 [if model year 1977]
                - 0.46253 [if model year 1978]
                + 0.61338 [if model year 1979].
```

This model produces an estimate that the percent belted decreased 1.2 percent for each one year increase in car age in the first six years these cars were on the road. Only model year 1974 was found to be significantly different from the others. Belt use in model year 1974 cars (with the interlock system) was 5.2 percentage points higher than would have been predicted from car age alone, at a time when belt use averaged only 9.9 percent in other cars.

This analysis suggests that between 1975 and 1980, there were no large changes in the cars themselves that might explain later belt use increases. It is possible that improvements made since 1980 contributed to belt use increases. However, it seems that most of the lower belt use in older cars resulted from differences in how older cars were used, rather than from design changes in later cars.

Driver Characteristics and Alcohol Use

Findings: Within driver age categories, belt use was substantially higher for women. Belt use was lower among those who had been drinking. For those who had been drinking, there were no differences in belt use across categories of previous crashes. However, for those who had not been drinking, belt use was lower among those with previous crashes.

Table 7 and Figure 7 show that belt use by those at risk of fatality was higher for older drivers and for women drivers. A linear model through the 28 data points representing drivers 15 through 84 years old (using the midpoint of the age range to represent each category) has an R-squared value of 0.96 (with 25 degrees of freedom) with the equation:

Percent belted = 13.13425
+ 0.45640 * Driver age in years
+ 11.65726 [for women drivers].

Belt use increased an estimated 4.6 percent for each ten-year increase in driver age, and was 11.7 percentage points higher for women than for men after controlling for driver age.

Table 7: Of Drivers at Risk of Fatality, Estimated Percent Belted -- by Driver Sex and Driver Age

Driver	Driver Sex		
Age	Male	Female	Total
10-14	15.4	0.0	10.2
15-19	24.7	34.9	28.3
20-24	22.0	36.8	26.4
25-29	24.7	36.8	28.6
30-34	26.4	40.2	31.2
35-39	28.1	42.4	33.3
40-44	32.5	43.2	36.7
45-49	31.6	50.0	39.0
50-54	34.8	50.1	41.3
55-59	38.9	51.7	44.2
60-64	42.1	46.9	43.9
65-69	45.9	56.0	49.8
70-74	50.1	60.0	54.0
75-79	50.6	58.0	53.6
80-84	54.1	62.8	56.8
85-89	45.4	51.6	46.9
90-94	47.6	-	43.1
Over 94	-	-	37.7
Unknown	11.5	0.0	9.7
Total	30.8	43.7	35.3

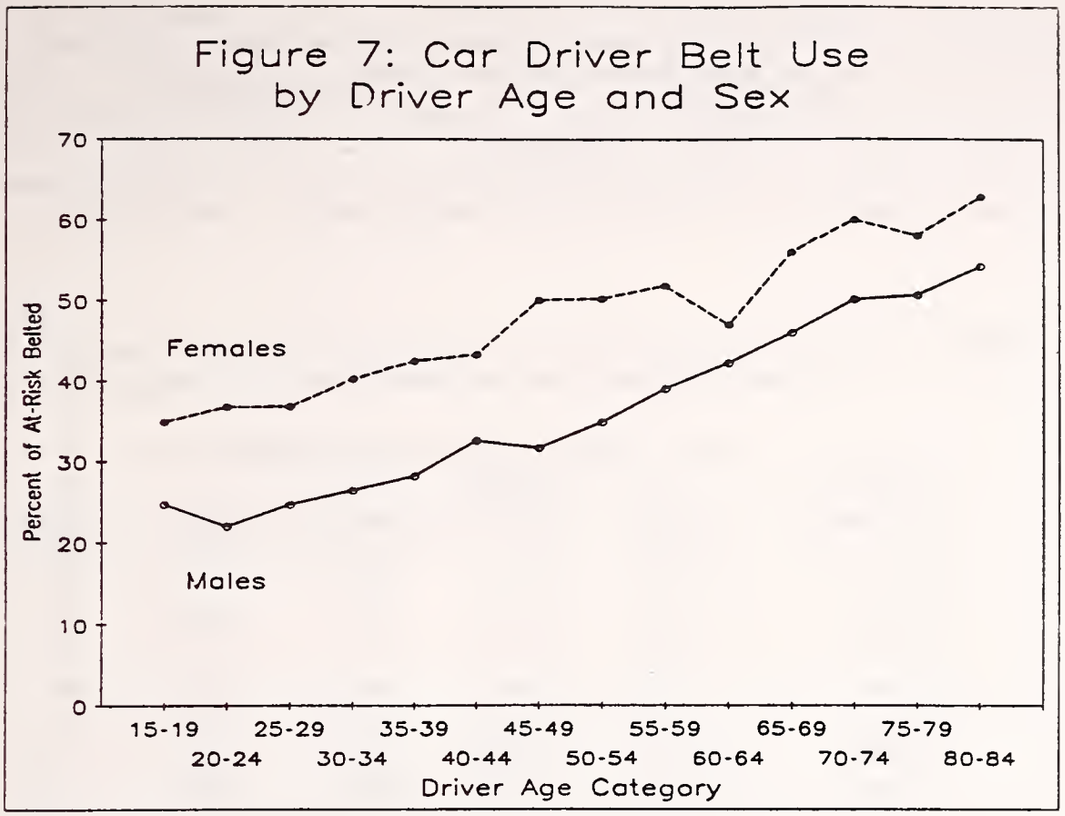


Figure 7: Car Driver Belt Use
by Driver Age and Sex
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
Females
Males
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
Driver Age Category

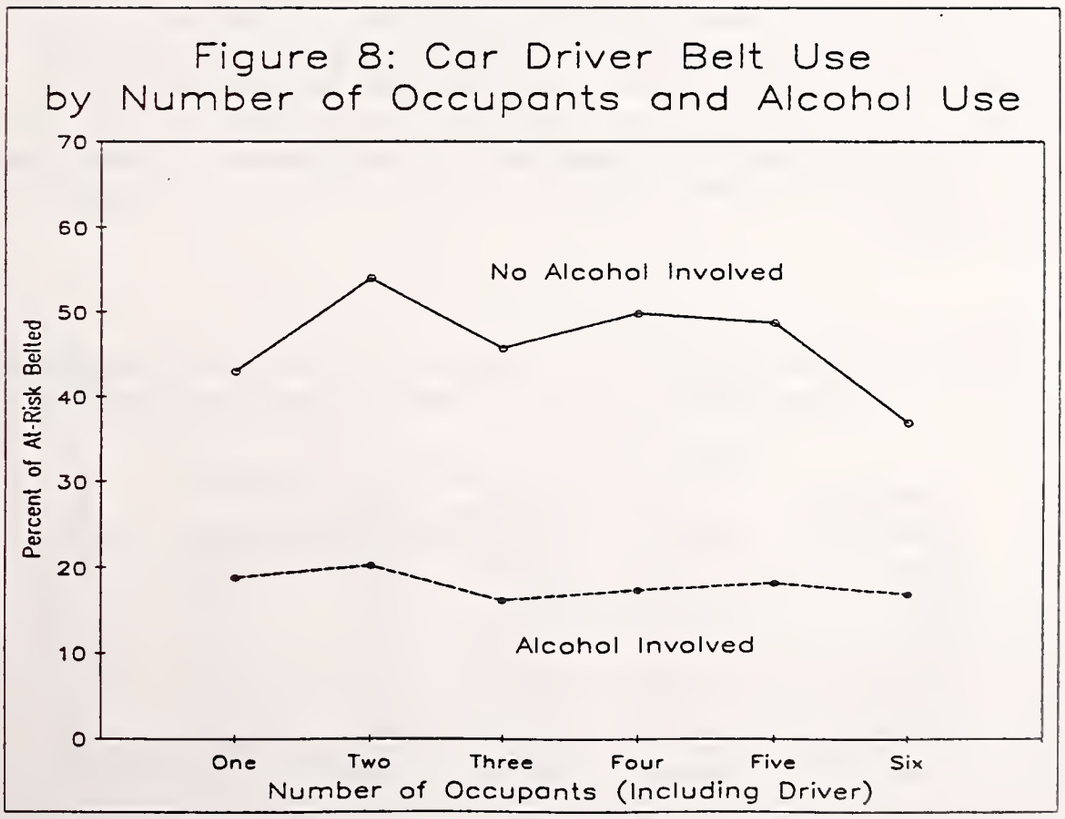


Figure 8: Car Driver Belt Use
by Number of Occupants and Alcohol Use
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
No Alcohol Involved
Alcohol Involved
One
Two
Three
Four
Five
Six
Number of Occupants (Including Driver)

Only 18.8 percent of drinking drivers at risk of fatality were belted, compared to 46.2 of those the police noted had not been drinking. This difference did not seem to depend on the number of occupants (including the driver in this count) in the car. Belt use was slightly higher for drivers with a single passenger (two occupants in the car) and lowest for cars with six occupants, but this was the case whether or not the police reported that alcohol was involved. The data are shown in Table 8 and Figure 8.

Table 8: Of Drivers at Risk of Fatality, Estimated Percent Belted -- Driver Alcohol Use and Number of Car Occupants

	Police-Reported Driver Alcohol Use				
Number of Occupants	No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
One	42.9	18.7	39.3	30.0	33.4
Two	54.0	20.2	45.9	37.2	41.1
Three	45.7	16.2	37.7	30.8	33.3
Four	49.8	17.3	47.9	35.4	37.6
Five	48.7	18.1	34.2	31.3	35.7
Six	36.9	16.8	38.2	23.5	29.0
Unknown	-	0.0	0.0	0.0	0.0
Total	46.2	18.8	40.9	31.6	35.3

Drivers with crashes previous to the one in which they were killed had lower belt use than drivers with no previous crashes. And the more previous crashes recorded, the lower the driver belt use in the fatal crash. The data are shown in Table 9 and Figure 9a. Figure 9b shows that belt use declined with increasing previous crashes among drivers who had not been drinking, but was uniformly low (around 18 to 20 percent) among those who had been drinking. Thus, the number of previous crashes appears to have predictive power for nondrinking drivers, but contains no additional information for drinking drivers.

Table 9: Of Drivers at Risk of Fatality, Estimated Percent Belted -- Driver Alcohol Use and Number of Previous Crashes

	Police-Reported Driver Alcohol Use				
Previous Crashes	No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
None	47.1	18.9	42.4	32.6	36.5
One	44.2	20.1	35.3	28.3	32.5
Two	39.6	11.4	28.3	29.7	26.4
Three	36.5	18.0	43.8	17.2	24.9
More	0.0	18.5	37.7	0.0	12.6
Unknown	31.8	18.1	32.7	22.6	25.7
Total	46.2	18.8	40.9	31.6	35.3

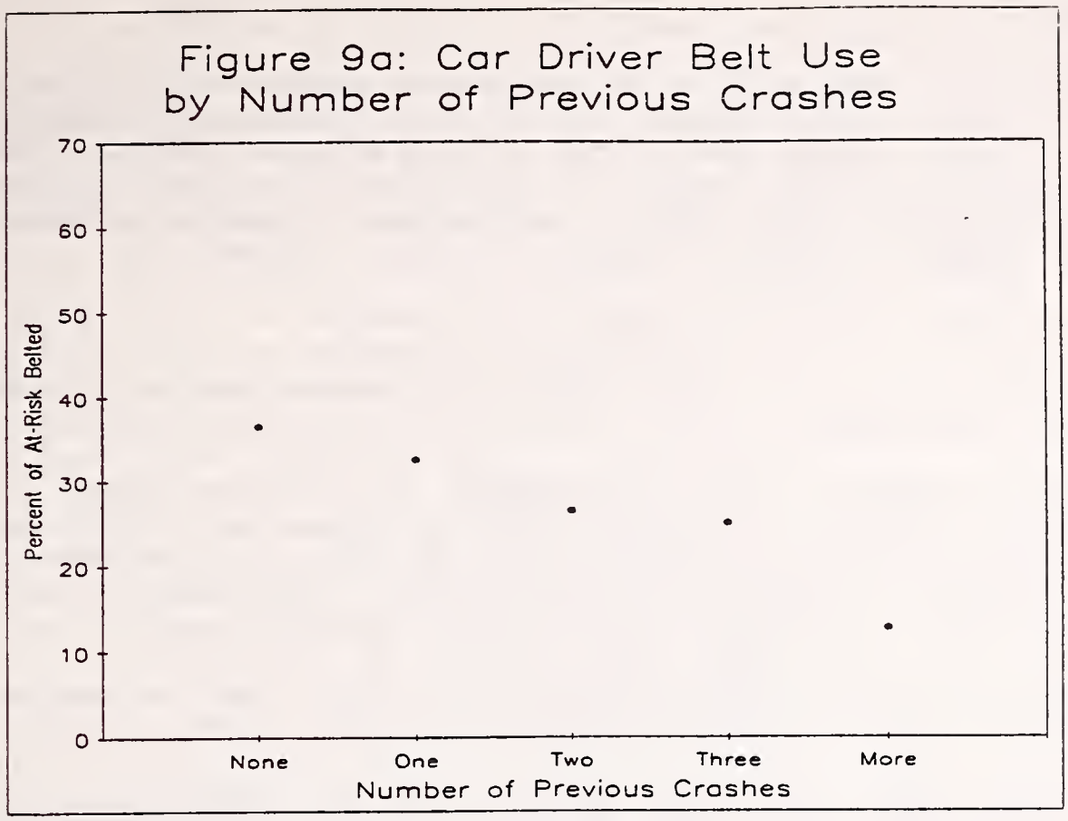


Figure 9a: Car Driver Belt Use
by Number of Previous Crashes
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
None
One
Two
Three
More
Number of Previous Crashes

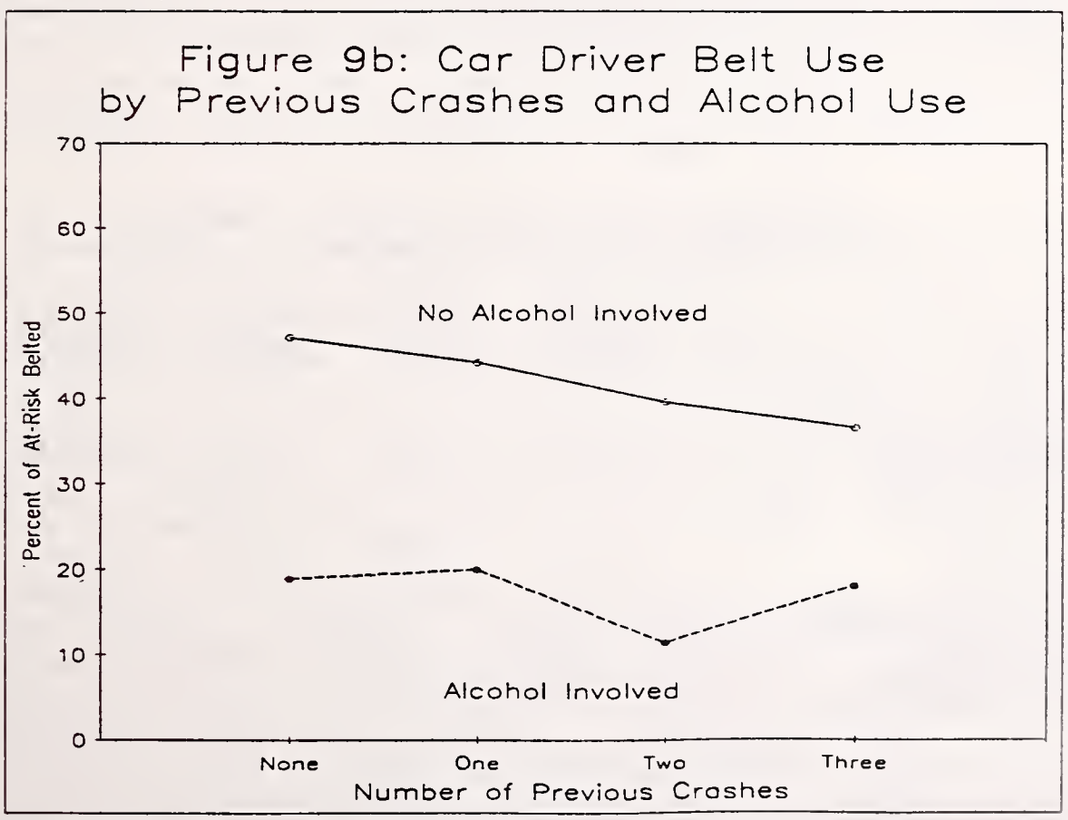


Figure 9b: Car Driver Belt Use
by Previous Crashes and Alcohol Use
Percent of At-Risk Belted
70
60
50
40
30
20
10
0
No Alcohol Involved
Alcohol Involved
None
One
Two
Three
Number of Previous Crashes

Discussion

Belt use by fatally-injured car drivers was substantially higher during the week (Monday through Friday), during the day (especially from 7:00 a.m. until 5:59 p.m.), among those who had not been drinking, and among those who had no previous recorded crashes. If these people tended to be careful drivers exercising normal discretion at the time of their crash, their belt use may resemble the belt use observed in traffic studies.

In contrast, belt use was much lower on weekends, at night, among those who had been drinking, and among those with previous recorded crashes. If these characteristics were associated with more-dangerous travel by drivers who tend to take greater risks, their belt use may be especially low.

Table 10 supports these two conjectures. Of 26,784 car driver fatalities included in this paper, 3,729 met the four conditions identified above as possibly being associated with less-dangerous travel. The belt use rate of those at risk of fatality under these conditions was 51 percent. This was slightly higher than the belt use rate of all nondrinking drivers (46 percent, from Table 9). It was also close to the belt use rate observed in traffic, which was 42 percent in 1987 and 46 percent in 1988, for a two-year average of 44 percent (Occupant Protection Trends in 19 Cities, NHTSA, July 1989).

There were also 608 fatalities that met all four conditions suggested for the more-dangerous travel. Belt use among drivers at risk of fatality under these conditions was 17 percent. This is close to the belt use rate for all drivers who had been drinking (19 percent, from Table 9). The additional restrictions (nighttime, weekend driving by those who have been involved previously in crashes) did not appear to affect the belt use rate of drinking drivers.

Table 10: Of Drivers at Risk of Fatality,
Belt Use Under More- and Less-Dangerous Conditions

Conditions	Belted Killed	Belted Lived	Unbelted Killed	Total At Risk	Belt Use
Daytime during the week, no alcohol use or previous crashes	1,374	1,124	2,355	4,853	51.5 %
All conditions	6,191	5,065	20,593	31,849	35.3 %
Nighttime on weekends, alcohol use and previous crashes	63	52	545	660	17.4 %

Thus, the belt use rate during the less dangerous conditions was three times the rate under the more dangerous conditions, and the belt use rate for the less dangerous conditions (and for nondrinking crash victims in general) was approximately that of drivers observed in traffic surveys.

Effects of Differences on Effectiveness Estimates

Crash Speed

Findings: Belt users tended to become involved in less-serious crashes, as measured by either the damage extent or the change in vehicle velocity during impact. However, after adjusting for these differences, belted drivers still had lower injury rates than did unbelted drivers.

Table 11 shows the moderate (rated as an AIS 2 or greater on the Abbreviated Injury Scale) and serious (AIS 3 and greater) driver injury rates in NCSS towed cars involved in frontal nonrollover collisions. Belted drivers (of cars on the road during the NCSS study period, from January 1977 through March 1979), had lower injury rates than did unbelted drivers. The belted driver moderate injury rate in frontal impacts was 56 percent lower than the rate for unbelted drivers; the belted serious injury rate in frontal impacts was 51 percent lower than that for unbelted drivers (Table 12).

Unbelted drivers in these frontal crashes tended to be in cars that received more extensive damage than was the case for belted drivers. Thus, the injury rate comparison is biased against unbelted drivers. One method of correcting for this bias is to reweight the data, so that the comparison is based on the same damage extent distribution. Reweighting the data in Table 12 to reflect the distribution of extent zones for the combined data set of belted and unbelted drivers (Table 11) yields lower estimated effectiveness estimates. Adjusted for differences in damage extent, belted drivers had a moderate injury rate 43 percent lower than that of unbelted drivers; the adjusted belted driver serious injury rate was 34 percent lower than that of unbelted drivers. These differences are an estimate of safety belt effectiveness, adjusted for differences in damage extent.

Damage extent reflects not only the crash severity, but also the vehicle size because frontal extent zones are defined in terms of nine zones between the front bumper and the windshield. Thus, more force is needed to damage a larger and heavier car to extent zone 4 (for example) than would be needed for a smaller and lighter car. To account for any confounding of car size (or of car age, since car age and size are interrelated) and belt use, the injury rate data can be corrected for the estimated change in vehicle velocity during the impact (the delta V). Driver injury rates by delta V categories are shown in Table 13. In these data, delta V was known for about 62 percent of the cases with a coded damage extent zone.

Belts appear to be more effective in preventing injury at lower crash severities, as shown in Table 14. Belts are estimated to be over 40 percent effective in preventing moderate injury when delta V was under 20 miles per hour (mph), but appear much less effective at higher crash speeds. Because unbelted drivers tended to be involved in higher speed crashes, the injury rates in Table 14 were reweighted to reflect the severity experience of the combined set of belted and unbelted drivers (Table 13). This results in estimates that belts were 43 percent effective in preventing moderate injury and in preventing serious injury. Thus, belts appear to reduce injury even after correcting for differences in the crash experiences of belted and unbelted drivers.

Driver Age and Alcohol Use

Findings: Belted drivers tended to be older than unbelted drivers and were less frequently reported to have been drinking before the crash. An analysis of the subset of fatal crashes involving young adult drivers suggests that the age differences did not affect the estimate of belt effectiveness. Similarly, an analysis of fatal crashes by alcohol involvement does not indicate that the association between belt use and alcohol nonuse affects estimates of belt effectiveness.

When a car is occupied by both a driver and a passenger, the safety belt use and the fatality outcome of the two occupants can be compared to produce an estimate of the effect of belt use on the odds of fatality. This is referred to as the matched-pairs method and has been used by various people to produce belt effectiveness estimates from FARS data. [The Methods section of this paper includes a reference to a paper by L. Evans that describes the procedure.] For example, Table 15 shows that when both occupants were belted, the odds of driver to passenger fatality were 0.995. When the driver, but not the passenger, was belted, the odds were 0.431. If these odds are treated like fatality rates, they produce an estimate that belts are 57 percent effective in preventing fatality (Table 16, driver as subject using an unbelted passenger control). Averaged across subjects and controls, the data in Table 15 produce an estimate that belts were 44 percent effective in preventing fatality in 1984 and 59 percent effective in 1987 (Table 16). The differences between the estimates may reflect statistical variability or the effect of belt laws on belt reporting.

When the data are restricted to those cars in which both the driver and the right front passenger were between 20 and 39 years old, there is very little change in the estimated belt effectiveness: an estimated 45 percent effective in 1984 (compared to 44 percent without the age restriction) and 61 percent effective in 1987 (compared to 59 percent across all ages). Thus, driver age does not seem to seriously bias belt effectiveness estimates produced by this method.

Two additional subsets of the 1984 and 1987 data were used to test the effect of differences in alcohol involvement on estimated belt effectiveness. For a small number of cases, the police reported that both the driver and the right front passenger had been drinking. For a larger number of cases, the police reported that neither occupant had been drinking. If estimates of belt effectiveness were really measuring differences in the survivability of drunk and sober people, there would be little or no estimated belt effectiveness after controlling for alcohol involvement. Table 16 shows that this is not the case. Belt effectiveness is about the same when there is no control for alcohol involvement (44 percent in 1984) as when neither occupant had been drinking (42 percent). There were inadequate 1984 data to estimate belt effectiveness when both occupants had been drinking. Similar results were obtained from the 1987 data. The belt effectiveness is estimated as 59 percent overall, 54 percent when both occupants had been drinking, and 56 percent when neither occupant had been drinking.

Thus, it appears that whatever effect alcohol use has on the ability of a crash victim to survive his injuries, that use does not greatly affect the estimates of belt effectiveness as calculated by the matched pairs method.

Table 13: Injury Rates in Frontal Towaway Crashes
-- by Total Delta V

Delta V (mph)	Belt Used	Total Drivers Raw	Total Drivers Weighted	Injured, AIS>=2 Weighted	Injured, AIS>=2 Percent	Injured, AIS>=3 Weighted	Injured, AIS>=3 Percent
00-09	No	1,051	6,798	196	2.88	118	1.74
	Yes	140	1,092	16	1.47	2	0.18
10-19	No	2,097	8,380	896	10.69	556	6.63
	Yes	129	596	36	6.04	36	6.04
20-29	No	790	1,509	496	32.87	425	28.16
	Yes	51	126	34	26.98	27	21.43
30-39	No	283	370	236	63.78	217	58.65
	Yes	9	12	7	58.33	7	58.33
40-49	No	90	111	82	73.87	82	73.87
	Yes	3	3	2	66.67	2	66.67
50-59	No	32	32	30	93.75	30	93.75
	Yes	0	0	0	-	0	-
60-69	No	10	13	13	100.00	9	69.23
	Yes	1	1	1	100.00	1	100.00
70-79	No	6	6	6	100.00	6	100.00
	Yes	0	0	0	-	0	-
80-89	No	1	1	1	100.00	1	100.00
	Yes	0	0	0	-	0	-
90-99	No	3	3	3	100.00	3	100.00
	Yes	0	0	0	-	0	-
Total	No	4,363	17,223	1,959	11.37	1,447	8.40
	Yes	333	1,830	96	5.25	75	4.10

Table 14: Safety Belt Effectiveness in Towaway Frontal Crashes
-- Adjusted for Differences in Total Delta V

Delta V (mph)	Effectiveness AIS>=2	Effectiveness AIS>=3
00-09	49.2	89.4
10-19	43.5	9.0
20-29	17.9	23.9
30-39	8.5	0.5
40-49	9.8	9.8
60-69	0.0	-44.4
Overall:		
Unadjusted	53.9	51.2
Adjusted	42.7	43.4

Table 11: Injury Rates in Frontal Towaway Crashes
-- by Damage Extent

Extent Zone	Belt Used	Total Drivers Raw	Total Drivers Weighted	Injured, AIS>=2 Weighted	Injured, AIS>=2 Percent	Injured, AIS>=3 Weighted	Injured, AIS>=3 Percent
1	No	1,745	10,739	326	3.04	181	1.69
	Yes	196	1,371	28	2.04	14	1.02
2	No	2,597	11,512	1,058	9.19	674	5.85
	Yes	187	1,098	37	3.37	32	2.91
3	No	1,181	3,122	721	23.09	597	19.12
	Yes	81	298	48	16.11	42	14.09
4	No	403	889	308	34.65	266	29.92
	Yes	11	50	3	6.00	3	6.00
5	No	213	499	160	32.06	140	28.06
	Yes	8	17	6	35.29	6	35.29
6	No	139	426	84	19.72	80	18.78
	Yes	8	20	4	20.00	4	20.00
7	No	101	170	80	47.06	76	44.71
	Yes	5	24	4	16.67	4	16.67
8	No	54	114	47	41.23	36	31.58
	Yes	5	8	3	37.50	3	37.50
9	No	160	412	91	22.09	90	21.84
	Yes	8	60	2	3.33	2	3.33
Total	No	6,593	27,883	2,875	10.31	2,140	7.67
	Yes	509	2,946	135	4.58	110	3.73

Table 12: Safety Belt Effectiveness in Towaway Frontal Crashes
-- Adjusted for Differences in Damage Extent

Extent Zone	Effectiveness AIS>=2	Effectiveness AIS>=3
1	32.7	39.4
2	63.3	50.2
3	30.3	26.3
4	82.7	79.9
5	-10.1	-25.8
6	-1.4	-6.5
7	64.6	62.7
8	9.0	-18.8
9	84.9	84.7
Overall:		
Unadjusted	55.6	51.3
Adjusted	42.9	33.9

Table 15: Fatalities in 1974 and Later Model Year Cars
When Both a Driver and a Right Front Passenger Are Present
(People Five Years and Older in Fatal Accidents)

Driver Subset (1984)	Safety Belt Used		Number of Deaths		Ratio of Fatalities	
	Driver	Passenger	Driver	Passenger	Drivers/ Passengers	Passengers /Drivers
Overall	No	No	2,596	2,608	0.995	1.005
	No	Yes	80	56	1.429	0.700
	Yes	No	47	109	0.431	2.319
	Yes	Yes	137	164	0.835	1.197
Both 20-39	No	No	840	798	1.053	0.950
	No	Yes	29	19	1.526	0.655
	Yes	No	18	44	0.409	2.444
	Yes	Yes	49	41	1.195	0.837
Both drunk	No	No	92	125	0.736	1.359
	No	Yes	2	1	2.000	0.500
	Yes	No	2	2	1.000	1.000
	Yes	Yes	1	0	*	0.000
Both sober	No	No	1,810	1,785	1.014	0.986
	No	Yes	62	42	1.476	0.677
	Yes	No	39	80	0.488	2.051
	Yes	Yes	121	146	0.829	1.207

Driver Subset (1987)	Safety Belt Used		Number of Deaths		Ratio of Fatalities	
	Driver	Passenger	Driver	Passenger	Drivers/ Passengers	Passengers /Drivers
Overall	No	No	2,671	2,605	1.025	0.975
	No	Yes	297	133	2.233	0.448
	Yes	No	132	353	0.374	2.674
	Yes	Yes	802	874	0.918	1.090
Both 20-39	No	No	965	892	1.082	0.924
	No	Yes	92	41	2.244	0.446
	Yes	No	35	107	0.327	3.057
	Yes	Yes	173	170	1.018	0.983
Both drunk	No	No	178	192	0.927	1.079
	No	Yes	10	9	1.111	0.900
	Yes	No	2	16	0.125	8.000
	Yes	Yes	15	19	0.789	1.267
Both sober	No	No	1,649	1,604	1.028	0.973
	No	Yes	185	84	2.202	0.454
	Yes	No	110	259	0.425	2.355
	Yes	Yes	683	755	0.905	1.105

* indicates not calculable

Table 16: Belt Effectiveness Calculated from Fatality Data
-- with Controls for Occupant Age and Alcohol Involvement

		Effectiveness in 1984				Effectiveness in 1987			
		by Alcohol Use			Both	by Alcohol Use			Both
Subject	Control	Total	Drunk	Sober	20-39	Total	Drunk	Sober	20-39
Driver	Unbelted passenger	57	-36	52	61	64	87	59	70
	Belted passenger	42	*	44	22	59	29	59	55
Passenger	Unbelted driver	30	63	31	31	54	17	53	52
	Belted driver	48	100	41	66	59	84	53	68
Driver	Average	49	*	48	41	61	58	59	62
Passenger	Average	39	82	36	48	57	50	53	60
Average	Unbelted control	44	14	42	46	59	52	56	61
	Belted control	45	*	43	44	59	57	56	61
Average	Average	44	*	42	45	59	54	56	61

* indicates not calculable

Discussion

The results do not suggest an alternative explanation to the lower injury and fatality rates experienced by belted occupants, beyond the benefits of the belts themselves. Drivers who were unbelted were more frequently reported to have been speeding or drinking, and to be younger than was the case for belted drivers. However, accounting for these factors produces belt effectiveness estimates that are consistent with those used by the agency. In the absence of another explanation for the lower fatality and injury rates observed for belted occupants, the data presented here suggest that as belt use increases, fatalities should decline and injury severity should be reduced.

FARS Definitions

The analysis was limited to fatally-injured passenger car drivers with police-reported belt use. The data were restricted to model years 1974 and later, to ensure that the car had been made with a driver's lap and shoulder belt. Tables 1 through 9 and supporting Tables A-1a through A-9b are from the combined 1987 and 1988 FARS data files, with the exception that Table 6 and supporting Tables A-6a and A-6b are from the 1975 through 1988 FARS files. The FARS data were classified as follows:

Restriction	Selection Criterion
Fatality	Injury Severity = 4
Driver	Person Type = 1
Belt Use Known:	
Belted	Manual Restraint Use = 1-8 or Automatic Restraint Use = 1 or 3
Not Belted	Manual Restraint Use = 0 with Automatic Restraint Use 0, 2, 4, or 9
Passenger Car	
Crash Years:	
1975-1981	Vehicle Body Type = 1-9, 39
1982-1987	Vehicle Body Type = 1-11, 67
Minicompact	Curb Weight up through 1,949 pounds
Subcompact	Curb Weight 1,950 through 2,449 pounds
Compact	Curb Weight 2,450 through 2,949 pounds
Intermediate	Curb Weight 2,950 through 3,449 pounds
Fullsize	Curb Weight 3,450 through 3,949 pounds
Largest	Curb Weight 3,950 pounds and over
Belt-Equipped	Model Year = 74-89

During 1987 and 1988 combined, about 79 percent of fatally-injured passenger car drivers were in a car of model year 1974 or later and had a determination of their belt use coded by the police. The model year and belt use coding restrictions eliminate about 21 percent of the car driver fatalities, as follows:

Car Driver Fatalities	Count	Percent
Belt Use Known		
Model Year 1974-on	26,784	78.76
Earlier Model Year	2,865	8.42
Unknown Model Year	66	0.19
Belt Use Unknown		
Model Year 1974-on	3,782	11.13
Earlier Model Year	492	1.45
Unknown Model Year	17	0.05
Total, 1987-1988	34,006	100.00

Most fatalities with unknown belt use were in states that do not routinely code belt use. To the extent that belt use in these states was similar to belt use in the rest of the country, the known data adequately represent the country. The small number of cars with model year unknown appear to pose no problems. However, the proportion of cars older than model year 1974 has been decreasing as these vehicles are replaced with newer models.

The matched pairs analysis was based on 1984 and 1987 FARS data for passenger cars, model years 1974 and later, with a single passenger reported as occupying the driver's seat (Seat Location = 11) and a single passenger reported in the right-front passenger's seat (Seat Location = 13), both of whom were at least five years old with safety belt use reported by the police.

NCSS Definitions

The NCSS data (collected from January 1977 through March 1979) were restricted to drivers involved in frontal nonrollover towaway crashes, as follows:

Restriction	Selection Criterion
Drivers	Seat Area = 1 and Location = 1
Towed	Applicable Vehicle = 1
Passenger Car	Body Styles = 1-4
Frontal	General Area of Damage = F
Nonrollover	Primary Damage Type not = 0 and Secondary Damage Type not = 0
Driver Injury:	
Moderate	Treatment Class 1-4 or Highest AIS = 2-6
Serious	Treatment Class 1-4 or Highest AIS = 3-6
Belt Use Known:	
Belted	Restraint Use (Investigator Coded) = 1-7
Not Belted	Restraint Use (Investigator Coded) = 0 or 8

The Highest AIS is a numerical rating of the Abbreviated Injury Scale (on a scale of 0 for those who are uninjured to 6 for those with injuries that are generally unsurvivable).

Estimates were produced by summing the Weighting Factor associated with each case, to reflect the sampling of cases within severity stratum.

FARS Fatality Counts

Tables A-1a through A-9b show the fatality counts from the combined 1987 and 1988 FARS files (Tables A-6a and A-6b from the 1975 through 1988 FARS data).

Table A-1a: Fatalities Reported as Belted
-- by Day of Week and Hour of Day

Hour Beginning	Day of Week							
	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Midnight	43	23	17	22	18	24	45	192
1 AM	59	13	12	8	31	26	56	205
2 AM	41	21	13	13	16	23	66	193
3 AM	23	5	11	11	12	10	42	114
4 AM	26	7	7	8	9	9	23	89
5 AM	17	13	13	21	17	13	27	121
6 AM	21	36	23	34	41	39	22	216
7 AM	19	61	40	44	44	37	35	280
8 AM	15	38	53	34	36	46	24	246
9 AM	28	40	55	34	32	32	41	262
10 AM	25	34	34	31	46	53	40	263
11 AM	33	47	47	52	37	49	53	318
Noon	31	48	46	38	47	48	47	305
1 PM	37	61	53	52	38	46	38	325
2 PM	44	53	45	52	55	69	57	375
3 PM	51	59	58	72	64	62	47	413
4 PM	64	69	53	50	72	74	51	433
5 PM	55	47	47	52	46	58	48	353
6 PM	44	38	37	36	37	53	51	296
7 PM	39	24	29	25	29	70	41	257
8 PM	34	18	28	31	33	40	34	218
9 PM	23	23	22	30	35	52	37	222
10 PM	32	28	17	39	34	53	42	245
11 PM	26	22	18	24	33	39	58	220
Unknown	5	4	4	4	6	3	4	30
Total	835	832	782	817	868	1,028	1,029	6,191

Table A-1b: Fatalities Reported as Unbelted
-- by Day of Week and Hour of Day

Hour	Day of Week							
Beginning	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Midnight	296	115	91	110	159	155	332	1,258
1 AM	324	79	82	113	148	163	354	1,263
2 AM	318	97	69	98	141	164	366	1,253
3 AM	223	61	48	59	87	99	264	841
4 AM	163	49	36	40	55	71	182	596
5 AM	109	52	60	39	53	79	115	507
6 AM	92	84	108	92	97	89	146	708
7 AM	74	117	98	108	99	101	94	691
8 AM	57	87	82	82	79	79	91	557
9 AM	57	71	95	92	76	72	72	535
10 AM	76	90	86	66	84	80	62	544
11 AM	72	76	102	76	86	109	92	613
Noon	77	88	93	80	100	105	107	650
1 PM	78	107	109	92	90	106	126	708
2 PM	110	126	121	113	103	134	132	839
3 PM	111	140	112	144	135	165	140	947
4 PM	124	131	118	131	157	160	164	985
5 PM	134	114	104	114	118	159	166	909
6 PM	134	87	100	140	146	148	174	929
7 PM	168	100	94	94	112	161	165	894
8 PM	130	100	113	117	129	152	167	908
9 PM	118	123	109	125	144	203	173	995
10 PM	129	101	98	128	145	235	193	1,029
11 PM	115	105	116	140	171	300	290	1,237
Unknown	39	14	20	18	23	35	42	197
Total	3,328	2,314	2,264	2,411	2,737	3,324	4,209	20,593

(Day of week and time of day were unknown for six unbelted fatalities.)

Table A-2a: Fatalities Reported as Belted
— by Speed Limit and Estimated Travel Speed

Speed Limit	Miles per Hour by which Travel Speed Exceeds Speed Limit: Slower Travel	Near Limit	Over by 10-19	Over by 20-29	Over by 30-39	More than 40	Unknown	Total
<30 mph	12	23	11	11	5	3	114	179
30 mph	24	19	8	6	5	9	221	292
35 mph	77	93	24	16	8	11	286	515
40 mph	40	57	13	9	8	4	277	408
45 mph	141	138	32	15	13	10	376	725
50 mph	42	33	6	2	3	4	293	383
55 mph	435	776	128	75	23	17	1,874	3,328
>55 mph	24	89	12	6	3	0	129	263
Unknown	0	0	0	0	0	0	98	98
Total	795	1,228	234	140	68	58	3,668	6,191

Table A-2b: Fatalities Reported as Unbelted
— by Speed Limit and Estimated Travel Speed

Speed Limit	Miles per Hour by which Travel Speed Exceeds Speed Limit: Slower Travel	Near Limit	Over by 10-19	Over by 20-29	Over by 30-39	More than 40	Unknown	Total
<30 mph	27	61	53	52	31	44	486	754
30 mph	49	83	44	59	29	48	837	1,149
35 mph	111	234	131	149	98	100	1,126	1,949
40 mph	96	172	61	46	36	37	781	1,229
45 mph	218	409	152	158	76	49	1,175	2,237
50 mph	83	152	32	39	22	16	871	1,215
55 mph	1,007	2,397	837	561	218	169	5,689	10,878
>55 mph	61	234	53	29	16	0	384	777
Unknown	0	0	0	0	0	0	405	405
Total	1,652	3,742	1,363	1,093	526	463	11,754	20,593

Table A-3a: Fatalities Reported as Belted
-- by Car Weight Class and Driver Age

Driver Age	Car Weight Class: Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
10-14	0	1	1	1	0	0	0	3
15-19	86	235	169	109	37	4	48	688
20-24	97	282	210	92	35	9	55	780
25-29	79	219	158	102	36	9	51	654
30-34	47	176	147	92	28	7	34	531
35-39	35	125	124	81	33	12	37	447
40-44	29	111	96	79	30	10	20	375
45-49	18	101	67	62	24	7	16	295
50-54	14	78	76	63	26	9	23	289
55-59	19	79	73	67	38	12	27	315
60-64	15	66	86	75	50	17	17	326
65-69	18	87	90	82	51	15	20	363
70-74	16	89	111	100	61	14	12	403
75-79	8	80	100	80	56	14	13	351
80-84	7	55	75	68	31	16	13	265
85-89	5	24	17	24	11	6	1	88
90-94	0	1	6	4	3	1	0	15
Over 94	0	0	0	1	1	0	0	2
Unknown	0	0	0	0	1	0	0	1
Total	493	1,809	1,606	1,182	552	162	387	6,191

Table A-3b: Fatalities Reported as Unbelted
-- by Car Weight Class and Driver Age

Driver Age	Car Weight Class: Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
10-14	5	8	12	10	9	2	2	48
15-19	301	964	769	641	245	59	198	3,177
20-24	387	1,092	931	825	332	121	260	3,948
25-29	258	846	672	597	275	118	206	2,972
30-34	182	575	458	442	233	105	133	2,128
35-39	119	451	374	325	167	98	95	1,629
40-44	87	270	252	263	153	68	81	1,174
45-49	72	215	170	184	104	51	44	840
50-54	37	161	146	187	107	64	46	748
55-59	37	176	138	162	107	66	36	722
60-64	48	151	156	182	133	52	35	757
65-69	22	134	152	163	106	61	28	666
70-74	26	135	116	156	106	53	33	625
75-79	12	109	127	150	102	26	26	552
80-84	7	83	71	105	57	28	16	367
85-89	7	43	41	45	21	15	9	181
90-94	1	13	5	10	2	5	0	36
Over 94	0	3	2	0	0	1	0	6
Unknown	1	3	5	3	1	1	3	17
Total	1,609	5,432	4,597	4,450	2,260	994	1,251	20,593

Table A-4a: Fatalities Reported as Belted
-- by Car Weight Class and Car Age

	Car Weight Class							
Car Age	Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
New	1	10	9	5	0	1	6	32
0	26	177	209	110	27	12	69	630
1	53	229	264	159	39	9	57	810
2	48	283	228	129	32	6	39	765
3	44	246	206	100	44	8	46	694
4	46	183	175	63	68	8	66	609
5	47	133	128	67	53	3	38	469
6	63	134	98	72	41	2	26	436
7	42	144	85	107	22	1	9	410
8	44	126	70	96	36	9	7	388
9	31	64	52	108	59	16	11	341
10	17	34	29	81	59	24	3	247
11	13	19	19	38	41	30	3	163
12	8	12	10	27	15	18	4	94
13	7	13	15	11	9	9	2	66
14	3	2	9	9	7	6	1	37
Total	493	1,809	1,606	1,182	552	162	387	6,191

Table A-4b: Fatalities Reported as Unbelted
-- by Car Weight Class and Car Age

	Car Weight Class							
Car Age	Mini-compact	Sub-compact	Compact	Inter-mediate	Fullsize	Largest	Unknown	Total
New	2	15	32	12	1	3	15	80
0	81	423	433	306	45	17	232	1,537
1	127	539	536	381	65	12	168	1,828
2	127	575	553	265	64	23	111	1,718
3	94	592	429	288	93	22	107	1,625
4	98	470	415	225	133	16	114	1,471
5	149	386	344	158	117	5	74	1,233
6	174	495	263	281	103	2	70	1,388
7	152	579	354	391	65	10	71	1,622
8	138	475	347	486	220	27	55	1,748
9	140	369	264	586	269	99	54	1,781
10	106	219	192	456	398	153	34	1,558
11	106	122	165	241	381	200	55	1,270
12	59	56	134	162	139	191	35	776
13	35	74	98	159	105	147	42	660
14	21	43	38	53	62	67	14	298
Total	1,609	5,432	4,597	4,450	2,260	994	1,251	20,593

Table A-5a: Fatalities Reported as Belted
-- Driver Age and Car Age

Driver Age	Car Age, in Years							
	Under 6	Six	Seven	Eight	Nine	Ten	Over 10	Total
10-14	1	1	1	0	0	0	0	3
15-19	369	59	50	60	64	35	51	688
20-24	493	59	53	48	44	26	57	780
25-29	432	50	35	33	35	25	44	654
30-34	354	40	41	23	16	27	30	531
35-39	306	27	32	35	15	8	24	447
40-44	251	23	20	26	21	17	17	375
45-49	220	18	11	16	7	13	10	295
50-54	181	23	23	21	18	12	11	289
55-59	219	24	16	15	20	9	12	315
60-64	222	18	25	16	18	14	13	326
65-69	243	31	22	26	19	11	11	363
70-74	270	23	26	23	24	12	25	403
75-79	226	18	24	22	22	16	23	351
80-84	166	16	22	15	11	9	26	265
85-89	45	5	9	8	5	11	5	88
90-94	8	1	0	1	2	2	1	15
Over 94	2	0	0	0	0	0	0	2
Unknown	1	0	0	0	0	0	0	1
Total	4,009	436	410	388	341	247	360	6,191

Table A-5b: Fatalities Reported as Unbelted
-- Driver Age and Car Age

Driver Age	Car Age, in Years							
	Under 6	Six	Seven	Eight	Nine	Ten	Over 10	Total
10-14	19	2	0	4	5	6	12	48
15-19	1,351	244	272	296	306	231	477	3,177
20-24	1,779	270	340	346	345	289	579	3,948
25-29	1,330	175	247	256	284	224	456	2,972
30-34	953	116	149	174	183	190	363	2,128
35-39	740	125	118	145	108	118	275	1,629
40-44	575	72	90	102	90	80	165	1,174
45-49	403	60	59	67	74	62	115	840
50-54	368	50	59	52	71	67	81	748
55-59	360	43	60	63	58	44	94	722
60-64	398	58	45	59	56	59	82	757
65-69	333	56	51	47	52	58	69	666
70-74	340	42	39	46	44	47	67	625
75-79	279	43	42	43	46	40	59	552
80-84	156	16	34	35	38	24	64	367
85-89	85	11	13	10	15	15	32	181
90-94	15	2	3	2	3	4	7	36
Over 94	1	2	1	0	1	0	1	6
Unknown	7	1	0	1	2	0	6	17
Total	9,492	1,388	1,622	1,748	1,781	1,558	3,004	20,593

Table A-6a: Fatalities Reported as Belted -- by Crash Year and Car Model Year

Model Year	Crash Year 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
1974	139	79	77	50	32	33	23	14	23	14	29	52	38	37	640
1975	61	47	32	30	27	18	17	17	9	12	32	42	24	28	396
1976	2	47	67	54	35	22	19	33	26	28	38	69	72	70	582
1977		2	54	59	36	49	31	26	31	36	74	91	95	91	675
1978			3	55	63	56	46	25	40	45	88	145	157	152	875
1979				6	57	70	50	37	51	61	105	135	183	184	939
1980					3	45	73	60	50	61	110	185	223	205	1,015
1981						1	45	54	43	74	130	190	206	187	930
1982							2	42	43	57	127	199	223	230	923
1983								1	63	77	129	205	241	246	962
1984									1	101	199	280	317	368	1,266
1985										4	181	314	333	377	1,209
1986											10	245	382	432	1,069
1987												21	299	428	748
1988													10	331	341
1989														22	22
Total	202	175	233	254	253	294	306	309	380	570	1,252	2,173	2,803	3,388	12,592

Table A-6b: Fatalities Reported as Unbelted -- by Crash Year and Car Model Year

Model Year	Crash Year 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Total
1974	973	1,000	986	1,172	1,106	1,070	977	841	710	690	529	503	363	298	11,218
1975	496	741	807	856	799	790	824	607	582	555	401	466	336	297	8,557
1976	37	654	1,062	1,043	1,098	1,076	951	842	791	791	674	657	570	440	10,686
1977		35	808	1,263	1,195	1,129	1,080	833	877	821	785	805	722	700	11,053
1978			53	1,197	1,489	1,290	1,285	1,059	1,075	1,036	900	943	887	836	12,050
1979				62	1,167	1,549	1,405	1,124	1,047	1,047	956	917	903	894	11,071
1980					73	1,008	1,367	1,104	996	987	874	849	887	845	8,990
1981						33	886	1,058	911	875	812	784	750	735	6,844
1982							51	670	887	843	774	652	637	638	5,152
1983								28	653	821	682	591	592	596	3,963
1984									54	891	1,009	853	797	879	4,483
1985										36	768	921	845	828	3,398
1986											41	727	929	873	2,570
1987												54	779	899	1,732
1988													49	758	807
1989														31	31
Total	1,506	2,430	3,716	5,593	6,927	7,945	8,826	8,166	8,583	9,393	9,205	9,722	10,046	10,547	102,605

Table A-7a: Fatalities Reported as Belted
-- by Driver Sex and Driver Age

Driver Age	Driver Sex Male	Female	Total
10-14	3	0	3
15-19	389	299	688
20-24	457	323	780
25-29	383	271	654
30-34	293	238	531
35-39	240	207	447
40-44	200	175	375
45-49	143	152	295
50-54	141	148	289
55-59	161	154	315
60-64	193	133	326
65-69	207	156	363
70-74	228	175	403
75-79	194	157	351
80-84	175	90	265
85-89	64	24	88
90-94	14	1	15
Over 94	2	0	2
Unknown	1	0	1
Total	3,488	2,703	6,191

Table A-7b: Fatalities Reported as Unbelted
-- by Driver Sex and Driver Age

Driver Age	Driver Sex Male	Female	Total
10-14	30	18	48
15-19	2,161	1,016	3,177
20-24	2,938	1,010	3,948
25-29	2,127	845	2,972
30-34	1,482	645	2,128
35-39	1,118	511	1,629
40-44	755	419	1,174
45-49	564	276	840
50-54	480	268	748
55-59	460	262	722
60-64	483	274	757
65-69	443	223	666
70-74	413	212	625
75-79	345	207	552
80-84	270	97	367
85-89	140	41	181
90-94	28	8	36
Over 94	5	1	6
Unknown	14	2	17
Total	14,256	6,335	20,593

(Sex was unknown for one unbelted fatality in the 30-34 age category; age and sex were unknown for one unbelted fatality.)

Table A-8a: Fatalities Reported as Belted
-- Driver Alcohol Use and Number of Car Occupants

Number of Occupants	Police-Reported Driver Alcohol Use: No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
One	1,792	549	727	679	3,747
Two	927	221	307	255	1,710
Three	203	55	64	53	375
Four	128	32	41	38	239
Five	36	8	10	10	64
Six	18	6	17	15	56
Unknown	0	0	0	0	0
Total	3,104	871	1,166	1,050	6,191

Table A-8b: Fatalities Reported as Unbelted
-- Driver Alcohol Use and Number of Car Occupants

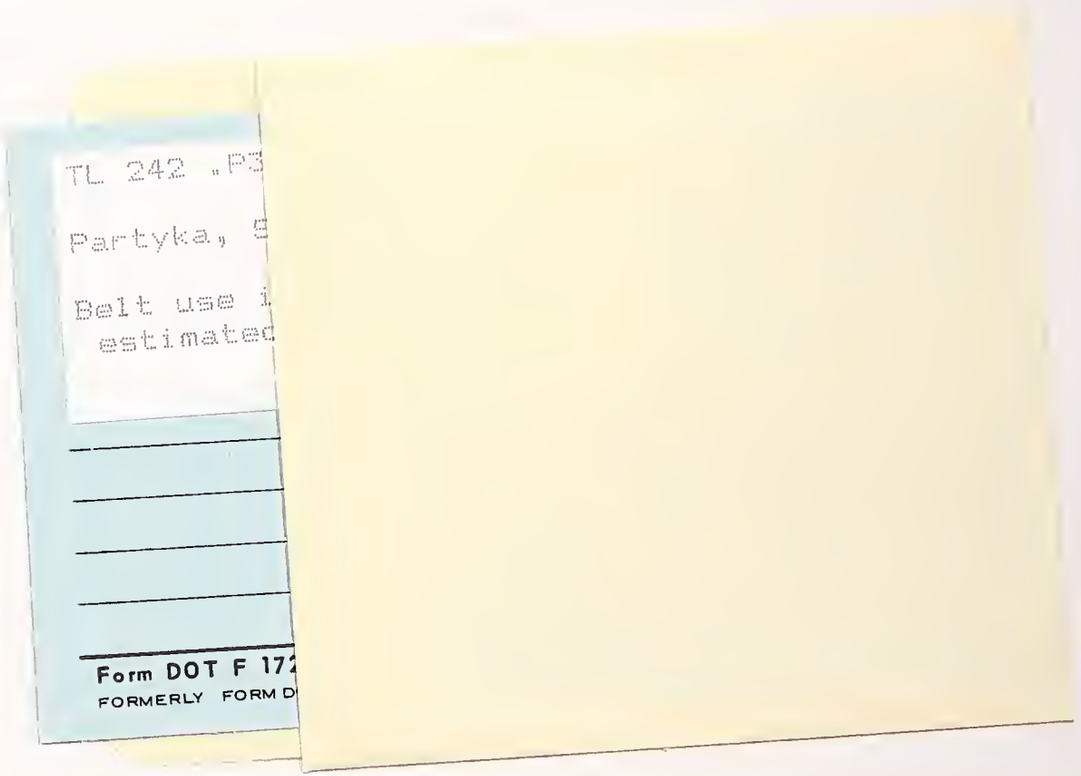
Number of Occupants	Police-Reported Driver Alcohol Use: No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
One	4,329	4,337	2,044	2,874	13,584
Two	1,434	1,586	657	783	4,460
Three	438	519	192	217	1,366
Four	235	279	81	126	721
Five	69	66	35	40	210
Six	56	54	50	89	249
Unknown	0	1	1	1	3
Total	6,561	6,842	3,060	4,130	20,593

Table A-9a: Fatalities Reported as Belted
-- Driver Alcohol Use and Number of Previous Crashes

Previous Crashes	Police-Reported Driver Alcohol Use: No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
None	2,628	673	985	877	5,163
One	373	148	134	123	778
Two	54	17	20	29	120
Three	6	7	6	4	23
More	0	2	1	0	3
Unknown	43	24	20	17	104
Total	3,104	871	1,166	1,050	6,191

Table A-9b: Fatalities Reported as Unbelted
-- Driver Alcohol Use and Number of Previous Crashes

Previous Crashes	Police-Reported Driver Alcohol Use: No Alcohol	Alcohol Reported	Not Reported	Unknown	Total
None	5,356	5,257	2,430	3,291	16,334
One	855	1,073	446	567	2,941
Two	150	240	92	125	607
Three	19	58	14	35	126
More	13	16	3	6	38
Unknown	168	198	75	106	547
Total	6,561	6,842	3,060	4,130	20,593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